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THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

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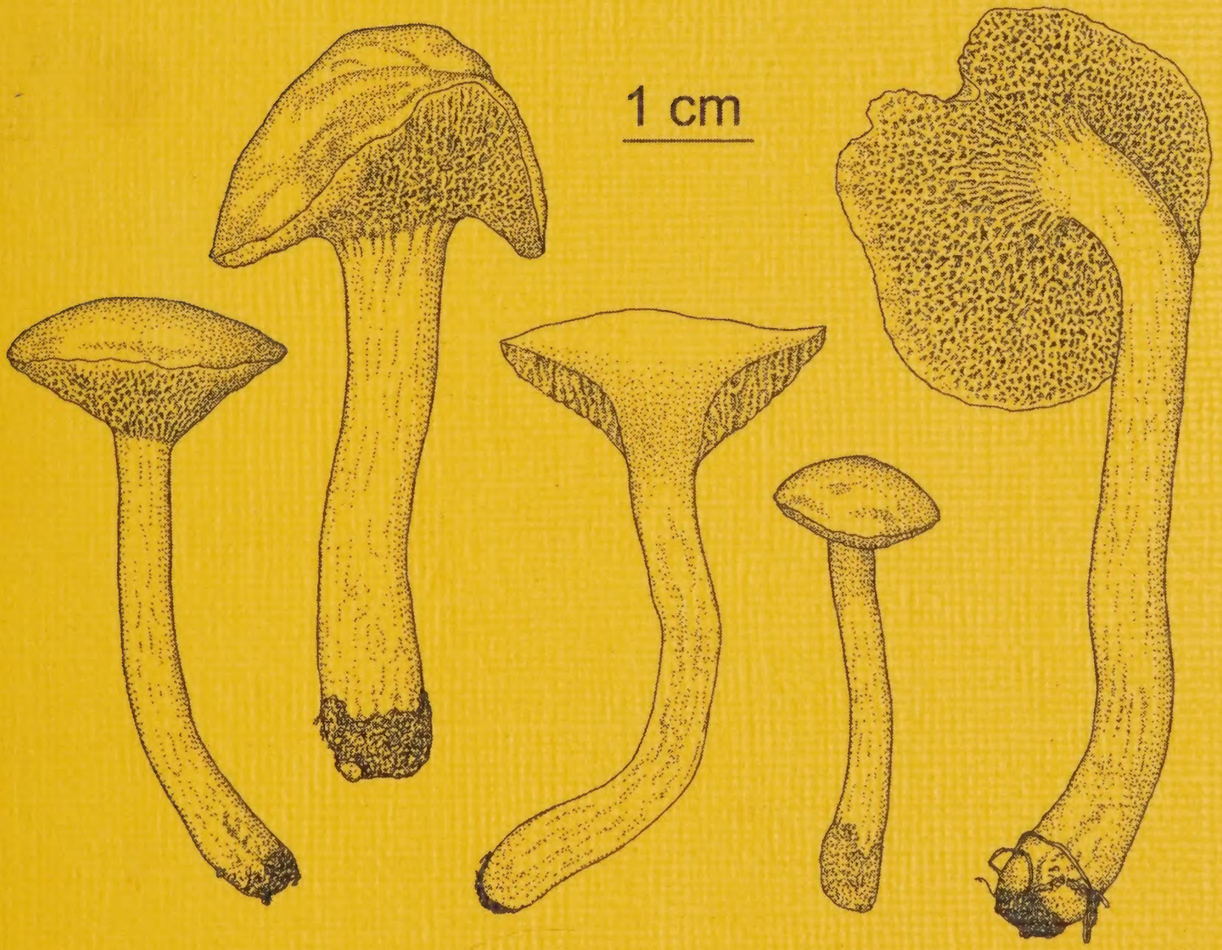

Omer Van de Kerckhove,
artist

DEGREEF & DE KESEL
Fig 1. *Chalciporus africanus*
(p. 331)

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MYCOTAXON

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Two new anamorphic fungi from Brazil: *Dictyochaetopsis polysetosa* and *Myrothecium compactum*

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Abstract — *Dictyochaetopsis polysetosa* anam. sp. nov. and *Myrothecium compactum* anam sp. nov. found on a decaying leaves of an unidentified plant in "Morro do Corcovado" and "Pista Claudio Coutinho" near Pão de Açucar, Rio de Janeiro, Brazil are described and illustrated. The former is characterized by verticillate, polysetose, branched conidiophores and the latter is distinguished by its compact conidiomata with coarsely verrucose to tuberculate, darkly green-brown marginal hyphae and bacilliform, aseptate, dark green conidia. A description and illustrations of the comparable taxon, *Dictyochaetopsis gonytrichoides*, are provided.

Key words — conidial fungi, leaf litter, systematics, tropical rainforest

Introduction

During an expedition in 2002 through the "Morro do Corcovado" and "Pista Claudio Coutinho" near the "Pão de Açucar" rainforest, Rio de Janeiro, Brazil, two conspicuous anamorphic fungi from the genera *Dictyochaetopsis* and *Myrothecium* were collected. Morphologically the two fungi were distinctly different from previously described species and are therefore described as new.

Materials and methods

Samples of submerged plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dishes, at 25° C, in moist chambers composed of plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol. The plant material was examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of × 1000. Micrographs were obtained with a Leite Dialux 20 EB microscope and a Jeol JSM-6400 scanning electron microscope using the techniques described previously by Figueras & Guarro (1988).

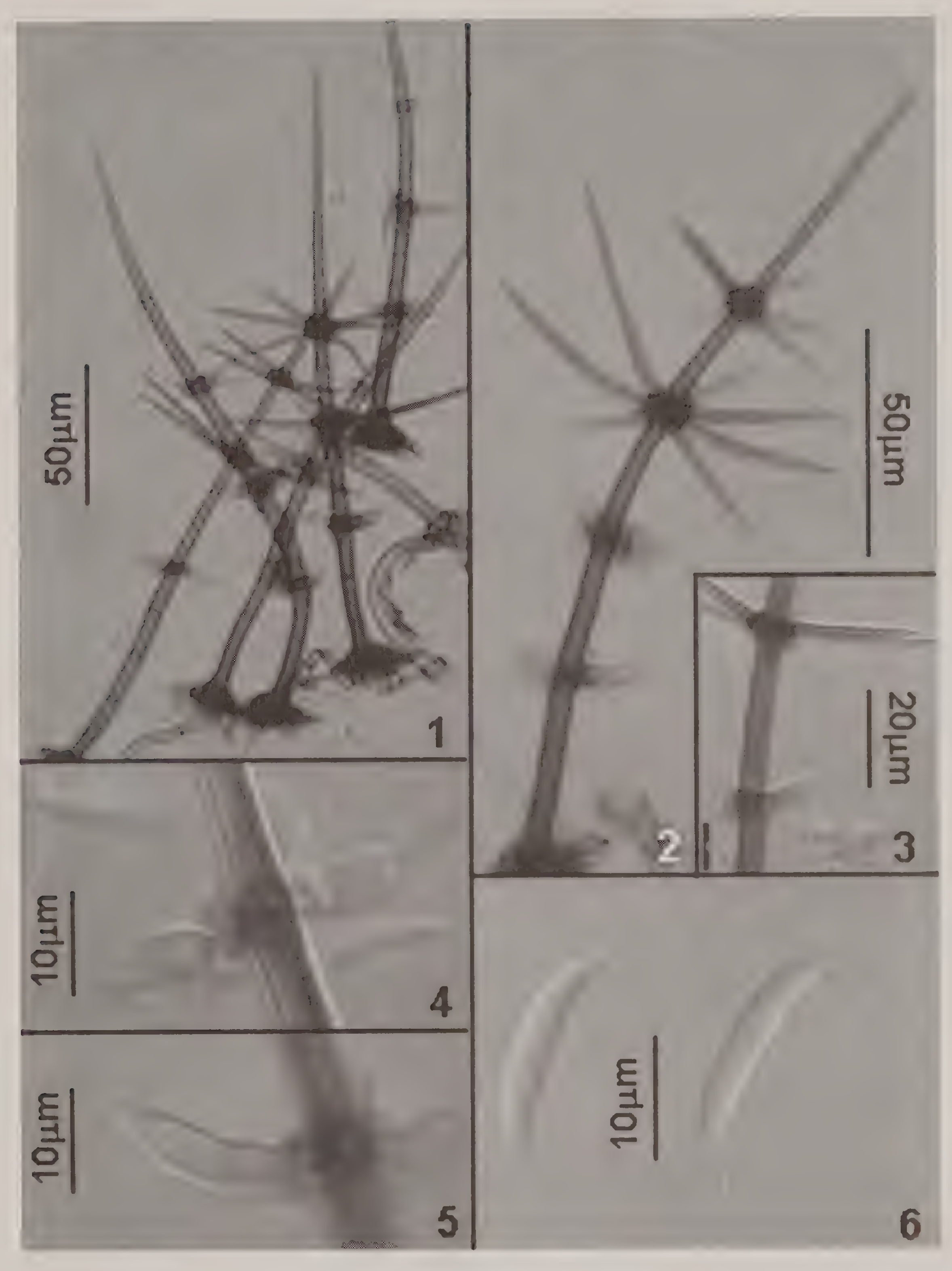
The fungi were isolated into pure culture by transferring single conidia observed under a stereo microscope onto oatmeal agar in Petri dishes, then incubated at 25° C under 12 h alternating cycles of daylight/dark.

Taxonomy

Dictyochaetopsis polysetosa R.F. Castañeda, Gusmão, Guarro & Saikawa,
anam. sp. nov. **Figs. 1-8**
MycoBank #: MB. 510905

Ad omnibus speciebus Dictyochaetopsis differt in conidiophoris polysetosis, verticillatim ramosis in partibus superioribus, 200–320 μm altis, 8–15 μm crassis ad basim et ramis setosis, atrobrunneis vel nigris, acicularis, 18–50× 8–9 μm. Conidia alantoidea usque ad falcata, 12–15 × 2 μm, hyalina, utrimque setulosa.

Etymology: Latin, *polysetosus*, referring to the setose branches of the conidiophores.



Figs. 1-6. *Dictyochaetopsis polysetosa* (From CBS H-6586a). **1-2.** Branched setiform conidiophores. **3-5.** Detail of conidiogenous cells. **6.** Conidia. Scale is indicated by bars.

Colonies on the natural substratum effuse, arboreo-pilose, amphigenous, black. Mycelium superficial and immersed composed of septate, branched, smooth-walled, 2–4 µm diam., brown hyphae. **Conidiophores** macronematous, mononematous, polysetose, acicular at the apex, 8- to 12-septate in the main axis, erect, straight or flexuous, dark brown to brown, smooth, 200–320 µm tall, 8–15 µm wide at the base, verticillate with 3-6 acicular, setose branches, which usually arise close to, and just below, the septa in the middle part of the conidiophore and towards the apical region; setose branches 1- to 3-septate, dark brown to brown, 18–50× 8–9 µm. **Conidiogenous cells** enterogenous, unilocal, discrete, lageniform or cylindrical, smooth-walled, brown, 9–14 × 4–7 µm, arising from superficial hyphae encircling the basal cell of the conidiophores and on the second to fourth septa of the main axis which usually lacks setose branches; or on the setose branches, with a conspicuous, 3.0–3.5 µm wide, 1.0–1.5 µm deep, infundibuliform collarette. **Conidia** accumulating in a white, slimy mass, falcate to allantoid, aseptate, hyaline, smooth, 12–15 × 2 µm, with a filiform appendage at each end, appendages 6–11 µm. **Teleomorph**: unknown.

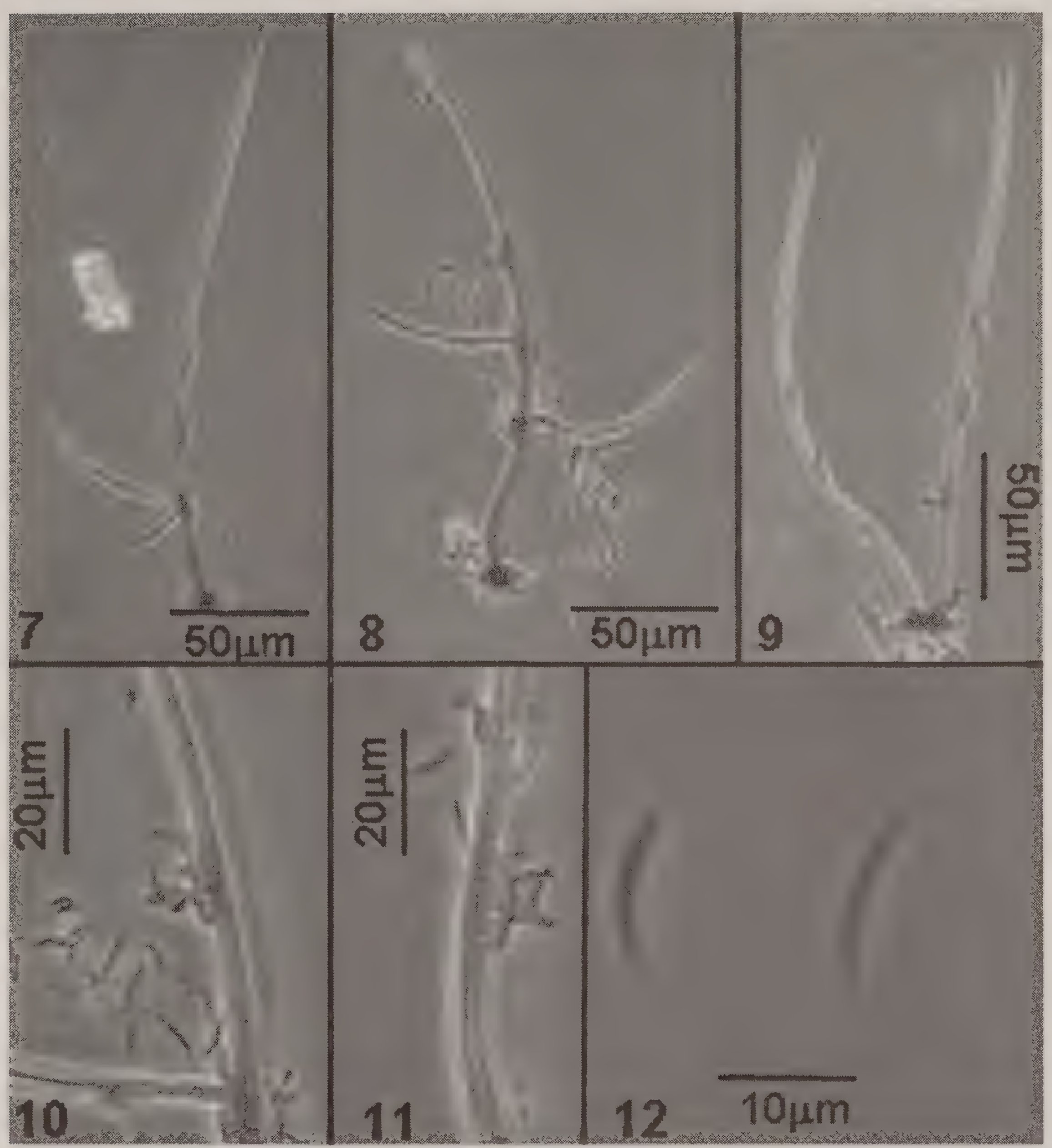
> Matrix: **BRAZIL. Rio de Janeiro, Rio de Janeiro**, "Morro do Corcovado", on decaying leaves of unidentified plant. Coll. A.M. Stchigel and J. Guarro, 12.X.2002, (INIFAT C02/57-3). **HOLOTYPE**: CBS H-6586a. **ISOTYPE**: HUEFS120867.

Dictyochaetopsis gonytrichoides (Shearer & J.L. Crane) Whitton, McKenzie & K.D. Hyde, Fungal Diversity 4: 156 (2000). **Figs 7-12**

Colonies on the natural substratum effuse, amphigenous, brown. Conidiophores setose, macronematous, mononematous, unbranched or branched with some sparsely or nodose setose branches and 2-7-fascicles of verticillate conidiogenous cells. Conidia accumulating in white, slimy mass, allantoid, 14–17 × 2.5–3.0 µm, hyaline, smooth, with a filiform appendage at each end, 6–10 µm long.

> Specimen examined: **BRAZIL. Piauí, Caracol**, "Serra das Confusões", on decaying leaves of unidentified plant. Coll. J.R. Rocha, 01.IV.2006. HUEFS105759. (Slide preparation).

COMMENTS: The genus *Dictyochaetopsis* was introduced by Arambarri & Cabello (1990) for species of *Dictyochaeta,* which produce enterogenous, lateral, sessile, lageniform, cylindrical to subulate, mostly discrete, sometimes integrated conidiogenous cells on setiform conidiophores. Twelve accepted species were treated in a taxonomical account by Whitton et al. (2000) and subsequently another species was added, *D. brasiliensis* M. Calduch et al. (Calduch et al. 2002). *D. polysetosa* is similar to *D. gonytrichoides* (Whitton et al. 2002) in conidial morphology, but differs in its setose conidiophores; the latter has sometimes setose branches that are pale brown to brown, sparse or nodose around the septa, and develop terminal conidiogenous cells. Conidiogenous cells in *D. gonytrichoides* are polyphialidic, mostly cylindrical or lageniform, mostly recumbent and brown, whereas *D. polysetosa* has acicular, setose branches that



Figs. 7-12. *Dictyochaetopsis gonytrichoides* (From HUEFS105759). **7-9.** General aspect of branched setiform conidiophores. **10-11.** Detail of conidiogenous cells. **12.** Conidia.
Scale is indicated by bars.

are dark brown to black, verticillate at the upper part of the conidiophores, and remain sterile.

Myrothecium compactum **R.F. Castañeda, Gusmão, Stchigel & M. Stadler, anam. sp. nov.** **Figs 13-20**

MycoBank #: MB 492172

Ad omnibus speciebus Myrothecii differt in conidiomatis compactis, mucosis, atroviridis ad usque nigris, 280–450 diam. et hyphis marginalibus coarctatis, grossis rugosis vel tuberculatis, atrobrunneo-viridis, apicibus capitulatis vel clavatis, 5–8 µm crassis. Conidia *bacilliformia, brunneo-olivacea, unicellularia, 7–8 × 1.5 µm, in massa nigra vel atroviridis, permucosa congesta.*

Etymology: Latin, *compactum*, referring to the compact arrangements of marginal hyphae and conidiogenous structures within the conidiomata.

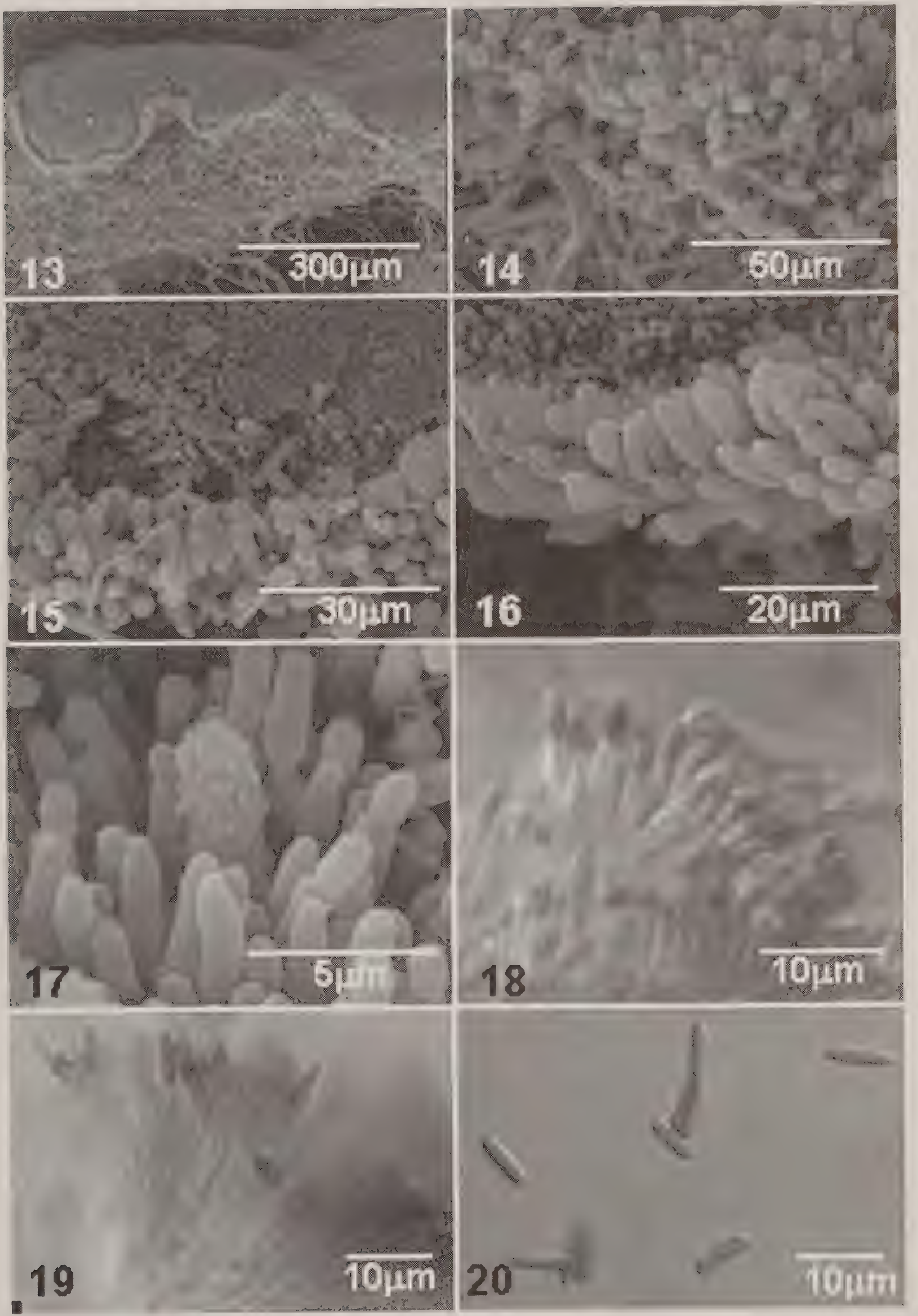
Conidiomata on the natural substratum sporodochial, scattered, amphigenous, pulvinate, gelatinous, dark green-brown to greenish black, 280–450 diam. **Mycelium** superficial and immersed. **Hyphae** septate, branched, 1.5–2.5 µm, hyaline to subhyaline, smooth. **Marginal hyphae** septate, unbranched or branched, capitate to clavate at the apex, coarsely rugose or tuberculate, pale brown-green below, dark brown green at the apex, very compactly grouped, encircling the conidiomata, 5–8 µm wide. **Conidiophores** macronematous, numerous, septate, tightly aggregated, 25–33 × 2–3 µm, subhyaline to pale green brown at the apex, smooth. **Conidiogenous cells** enterogenous, discrete, determinate, penicillate, unilocal, cylindrical to slightly subulate, with an inconspicuous opening, slightly brown-green, smooth; forming a very compact turf. **Conidia** accumulating in a black to darkish green, very gelatinous mass, holoblastic, bacilliform, aseptate, dark olivaceous-brown, smooth, 7–8 × 1.5 µm. **Teleomorph**: unknown.

Matrix: **BRAZIL, Rio de Janeiro, Rio de Janeiro**, "Pista Cláudio Coutinho", near Pão de Açúcar, on decaying leaves of unidentified plant. Coll. A.M. Stchigel and J. Guarro, 12.X.2002, (INIFAT C02/63). HOLOTYPE: CBS H-6584a. ISOTYPE: HUEFS120874 (slide preparation).

Culture from the holotype: **Colonies** on corn meal agar 25–31 mm after 7 days at 25° C, floccose, greenish gray. **Reverse** gray. **Hyphae** thick walled, septate, hyaline, 1.5–2.5 µm diam, smooth. **Sporulation** obtained after five days, conidia similar to those observed *in vivo*.

Cultures deposited: CBS 111739, IMI 390539.

Comments: The genus *Myrothecium* Tode: Fr. was treated in a taxonomic account by Tulloch (1972). The generic concept is broadly applied to taxa with sporodochial and synnematous conidiomata with or without marginal hyphae, mostly hyaline setae, sometimes stained by the pigment present in the mucilaginous mass of conidia. Conidiogenous cells are arranged in most of the species on somewhat penicillate conidiophores that form a turf in the pulvinate conidiomata. *M. compactum* can be compared with species that have ornamented marginal hyphae and non-setose conidiomata, such as *M. longistriatisporum* Matsush. (Matsushima 1971), *M. masonii* M. C. Tulloch (Tulloch 1972) and *M. renaudii* Escalona (Escalona 1997). However, *M. longistriatisporum* has fusiform, longitudinally striate, conidia, 12–16 × 3–4 µm; *M. masonii* has long, synnematal conidiomata and ellipsoid, subhyaline to pale olivaceous conidia, 4.5–9.0 × 1.5–2.5 µm; *M. renaudii* has synnematous conidioma and cylindrical to oblong, subhyaline to pale olivaceous conidia, 7–19 × 3–6 µm.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Figs. 13-20. *Myrothecium compactum* (From CBS H-6584a). **13.** General aspect of sporodochia (SEM). **14-16.** Mass of conidia and marginal hyphae (SEM). **17.** Detail of verrucose or tuberculate marginal hyphae (SEM). **18-19.** Conidia production and tightly aggregated conidiogenous cells. **20.** Conidia. Scale is indicated by bars.

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Dr. Mary Palm (APHIS, United States Department of Agriculture) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank Ciencia y Tecnología para el Desarrollo (CYTED RED-XII.J) and the Cuban Ministry of Agriculture for facilities. The author RFCR thanks Drs. David W. Minter, Pedro Crous, Uwe Braun, Ludmila Marvanová, Cony Decock, Jerry A. Cooper, Rosa M. Arias, Antonio Hernández-Gutiérrez and Josep Cano for their generous and valuable assistance with literature not available in our library. The author LFP Gusmão thanks the CNPq (proc. 471619/2004) for financial support.

Literature cited

Arambarri AM, Cabello MN. 1990. Considerations about *Dictyochaeta*, *Codinaeopsis* and a new genus *Dictyochaetopsis*. Mycotaxon 38: 11–14.

Calduch M, Gené J, Stchgel AM, Guarro J. 2002. New species of *Dictyochaetopsis* and *Paraceratocladium* from Brazil. Mycologia 94: 1071–1077.

Escalona F. 1997. *Myrothecium renaudii* sp. nov. on *Heliconia psittacorum*, *H. spathocircinata* Mycotaxon 61: 81-86.

Figueras MJ, Guarro J. 1988. A scanning electron microscopic study of ascoma development in *Chaetomium malaysiense*. Mycología 80: 298–306.

Matsushima T. 1971. Microfungi of the Solomon Islands and Papua-New Guinea. 1-78, Osaka, published by T. Matsushima.

Tulloch M. 1972. The genus *Myrothecium* Tode ex Fr. Mycol. Pap. 130: 1–42.

Whitton SR, McKenzie EHC, Hyde KD. 2000. *Dictyochaeta* and *Dictyochaetopsis* species from the *Pandanaceae*. Fungal Diversity 4: 133-158.

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RAPD patterns in three Argentine *Coprotus* species: a test case

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Abstract - The genus *Coprotus* consists of coprophilous fungi in the *Pyronemataceae*. 44 monosporic strains were morphologically identified as *Coprotus lacteus*, *C. niveus*, and *C. sexdecimsporus*. Using random amplified polymorphic DNA (RAPD) to analyse two *C. lacteus*, five *C. niveus*, and two *C. sexdecimsporus* geographical groups, the authors obtained diagnostic bands for species recognition, estimated polymorphism levels within species, analysed inter-species phenetic relationships, and compared the findings from the RAPD study to those from a previous isozyme study. The phenogram obtained from Nei´s genetic distances matrix was similar to the one previously obtained by isozyme markers. Both matrices show strains grouping into three defined clusters, each representing one of the three species analysed. The difference between the similarity levels among species and those observed in the isozyme report are compared and discussed. The results of this study support the use of RAPD markers as a reliable tool comparable to traditional morphological and isozyme methods.

Key words - *Ascomycota*, taxonomy

Introduction

The genus *Coprotus* Korf ex Korf & Kimbr. includes coprophilous discomycetes fungi, which belong to the *Pyronemataceae* Corda. From an ecological point of view, these fungi are very important since they have the ability to grow saprophytically on herbivore dung transforming it into humus. They also have the ability to perform the biological degradation of cellulose (Wicklow et al. 1980), which contributes to soil fertilization.

Coprophilous fungi have a cosmopolitan distribution due to the dispersion of their spores by animals, wind and water, and also to the fact that spores often adhere to forage and are usually transported over long distances.

Most of these fungi are homothallic, probably originating as an adaptation to the substrate, which determines their sexual isolation (Wicklow 1981). Sexual reproduction enables ascospore dispersal by effective discharge methods.

Traditional characterization of *Coprotus* species is based on cytological and morphological characters (Kimbrough et al. 1972). However, in many cases, the analyses of these characters have led to uncertainties in the identification of some species, because they often overlap and some of them vary according to culture conditions.

In an earlier study, Suárez et al. (2006) performed an isozyme analysis in order to confirm previous morphological identification of *Coprotus* species and to detect intraspecific variability. In that study, the isozymes showed scarce intraspecific variability and confirmed the previous identification of the strains using morphological characters, although only few species-specific bands were found.

In order to obtain a greater number of diagnostic bands, which could allow a better differentiation of the *Coprotus* species, new molecular markers seem to be necessary.

During the last decade, molecular techniques have been widely used as alternative methods for taxonomic studies, providing important tools for species characterization (Maclean et al. 1993). Among the wide variety of techniques, the random amplified polymorphic DNA (RAPD) (Williams et al. 1990) is a powerful tool for rapid detection of DNA polymorphisms among species.

This method has also been successfully used in taxonomic and evolutionary studies of fungi (Crowhurst et al. 1991, Aufauvre-Brown et al. 1992, Khush et al. 1992, Mills et al. 1992, Smith et al. 1992, Vaillancourt & Hanau 1992, Jacobson et al. 1993, Yoon & Glawe 1993, Cooke et al. 1996, Glienke-Blanco et al. 2002, Frazzon et al. 2002, Doherty et al. 2003).

Individuals of the genus *Coprotus* are homothallic and produce clonal offspring (Rayner 1994), which leads to low morphological and isoenzymatic variability.

Taking into account that a large number of amplicons can be screened in a relatively short period, RAPD is especially useful for the characterization of clonal lineages and for establishing phenetic relationships among species with scarce morphological differentiation (McDonald 1997).

This study represents the first report on RAPD markers able to differentiate three species of the genus *Coprotus*. We applied RAPD technique with the purpose of i) estimating levels of polymorphism within species, ii) obtaining diagnostic bands for species recognition, iii) analyzing the phenetic relationships among species and iv) comparing and contrasting the findings of the RAPD study to that of a previous isozyme study.

Materials and methods

Isolation and maintenance of monosporic strains

Mature apothecia of *Coprotus lacteus* (Cooke & W. Phillips) Kimbr. et al. and *Coprotus niveus* (Fuckel) Kimbr. et al. (Kimbrough et al. 1972), and *Coprotus sexdecimsporus* (P. Crouan & H. Crouan) Kimbr. & Korf (Kimbrough & Korf 1967) were obtained by placing cow and horse dung from different geographical locations in Petri dishes with a layer of filter paper. The isolation and maintenance of monosporic strains followed the procedure indicated by Suárez et al. (2006). Forty-four monosporic strains, from each geographical location were obtained (Table 1). All strains were deposited in the Herbarium and Culture Collection of the Department of Biodiversity, Faculty of Natural & Exact Sciences, University of Buenos Aires (BAFC).

Table 1. List of strains with their geographical location*, substrate, and BAFC number.

STRAIN	LOCATION	SUBSTRATE	BAFC	STRAIN	LOCATION	SUBSTRATE	BAFC
	Coprotus lacteus				*Coprotus niveus*		
lacA1	Agronomía	cow dung	874	nivE1	Bahía Ensenada	cow dung	1956
lacA2	Agronomía	cow dung	1936	nivE2	Bahía Ensenada	cow dung	982
lacA3	Agronomía	cow dung	1937	nivE3	Bahía Ensenada	cow dung	1957
lacA4	Agronomía	cow dung	1938	nivE4	Bahía Ensenada	cow dung	1958
lacA5	Agronomía	cow dung	1939	nivE5	Bahía Ensenada	cow dung	1959
lacA6	Agronomía	cow dung	1940	nivC2	Campana	cow dung	1960
lacA10	Agronomía	cow dung	1941	nivC3	Campana	cow dung	1961
lacA13	Agronomía	cow dung	1942	nivC4	Campana	cow dung	1962
lacA14	Agronomía	cow dung	1943	nivC5	Campana	cow dung	1963
lacL1	Villa Lugano	cow dung	1944	nivU1	Ciudad Universitaria	horse dung	1964
lacL3	Villa Lugano	cow dung	1945	nivU3	Ciudad Universitaria	horse dung	1965
lacL4	Villa Lugano	cow dung	1946	nivU6	Ciudad Universitaria	horse dung	1966
lacL6	Villa Lugano	cow dung	1947	nivU7	Ciudad Universitaria	horse dung	1967
	Coprotus sexdecimsporus			nivU8	Ciudad Universitaria	horse dung	1968
sexG1	Los Gigantes	cow dung	1948	nivBC1	Bahía Craft	cow dung	1969
sexG2	Los Gigantes	cow dung	873	nivBC2	Bahía Craft	cow dung	1970
sexG3	Los Gigantes	cow dung	1949	nivBC3	Bahía Craft	cow dung	1971
sexG4	Los Gigantes	cow dung	1950	nivBC4	Bahía Craft	cow dung	1972
sexG7	Los Gigantes	cow dung	1951	nivL1	Villa Lugano	cow dung	1973
sexU1	Ciudad Universitaria	horse dung	1952	nivL3	Villa Lugano	cow dung	1974
sexU2	Ciudad Universitaria	horse dung	1953	nivL4	Villa Lugano	cow dung	1975
sexU4	Ciudad Universitaria	horse dung	1954	nivL5	Villa Lugano	cow dung	1976
sexU5	Ciudad Universitaria	horse dung	1955				

*Bahía Craft: Villa La Angostura, Neuquén province; Bahía Ensenada: Tierra del Fuego province; Campana: Buenos Aires province; Los Gigantes: Córdoba province, Agronomía, Ciudad Universitaria and Villa Lugano are different locations in Buenos Aires city

Identification of species

The characters used to identify the *Coprotus* species were the same used by Kimbrough et al. (1972). Other characters like the distribution and appearance of apothecia in PF medium (yeast extract, 3 g; agar 18 g; distilled water, 1000 ml; a slice of filter paper) (Ranalli & Forchiassin 1974) and the germination of ascospores in AA medium (Bacto agar, 20g; distilled water, 1000 ml) were also used. Studies of spore germination and ascocarp development were performed on AA plates and in PF medium plates respectively. The latter were incubated at 23 °C under continuous light.

DNA extraction

The mycelium was obtained using the Suárez et al. (2006) procedure and ground to powder in liquid nitrogen using a sterile pestle. Genomic DNA was extracted from the mycelium according to the method of Dellaporta et al. (1983).

DNA concentration was estimated by comparing electrophoretic patterns on 0.8 % agarose (in 1x TAE buffer) gels with standard DNA marker sets (phage λ) double digested with EcoRI and HindIII.

Polymerase chain reaction

PCR was carried out in 50 μl final volume using 40-60 ng of genomic DNA, 5 μl dNTP mix (100 μM), 6 μl $MgCl_2$ (25 mM), 10 μl primer (3 ng/μl), 5 μl 10x Taq DNA polymerase buffer (10mM tris-HCl, pH 9 at 25 °C, 50 mM KCl, 0.1% Triton X-100) and 0.5 μl of Taq DNA polymerase (Promega) (0.5 units/μl). The mixture was amplified in a thermal cycler (Techne Gene E). The thermal cycler was programmed for one cycle of 94 °C for 6 min., 45 cycles of 94 °C for 1 min., 36 °C for 1 min. and 72 °C for 2 min., followed by a final extension step of 72 °C for 6 min.

Two PCR amplifications per individual were carried out to ensure repeatability of banding patterns. The usual caution needed to prevent contamination of PCR experiments with previously amplified fragments was considered. In particular, pre and post-amplification procedures were separated and fresh aliquots of reagents were used for each experiment wherever possible. To test the reliability of PCR products, several controls were routinely used: one without primer, a second one without Taq DNA polymerase, and the third with no genomic DNA. No amplification occurred in any of these controls.

Twenty arbitrary primers (Promega, series A and B) were screened for suitability in a small number of individuals. Only those primers that produced clear RAPD bands for all of the fungal isolates and in addition resulted the most informative to detect polymorphisms were chosen. These primers were: A01 (5´CCC AAG GTC C3´), A02 (5´GGT GCG GGA A3´), A10 (5´ACG GCG TAT G3´), B08 (5´TCA CCA CGG T3´), B09 (5´ATG GCT CAG C3´) and B10 (5´CAG GCA CTA G3´). The 85 bands that appeared consistently in all experiments were used in the study.

DNA fragment analysis

The amplification products were resolved on 1.4% agarose gels stained with EtBr (0.5μg/ml). Fragments were observed and photographed on a UV transilluminator (312 nm).

Statistical methods

The nine geographical groups of strains of *C. lacteus* (lacA and lacL), *C. niveus* (nivU, nivC, nivBC, nivL and nivE) and *C. sexdecimsporus* (sexG and sexU) were considered as operative taxonomic units (OTUs), because no RAPD pattern variation was detected among monosporic strains of the same geographic location.

RAPD bands were scored as presence (1) or absence (0). The matrix data was used to estimate Nei's (1978) genetic distance. Calculations were made using the RAPD programs by Black IV (1996). A phenogram was obtained from Nei's distance matrix by the UPGMA method using the program STATISTICA (ver. 6.0) (Statsoft, Inc. 2001). The reliability of its branches was evaluated by the analysis of consensus of 100 trees obtained from 100 bootstrapped pseudoreplicates of the original data matrix. Bootstrapping was performed using Black IV (1996) programs, and the consensus analysis was done with the PHYLIP program (Felsenstein 1993). The approach used to estimate the levels of polymorphism for each species was the percentage of polymorphic loci (P = N° of polymorphic loci/ N° of loci analyzed).

Results

RAPD genetic variability

The analysis of six primers yielded a total of 91 bands. Only 85 of these bands were variable and useful for comparison among species and were used in this study. Figures 1 and 2 show RAPD patterns obtained with primers A02 and B09.

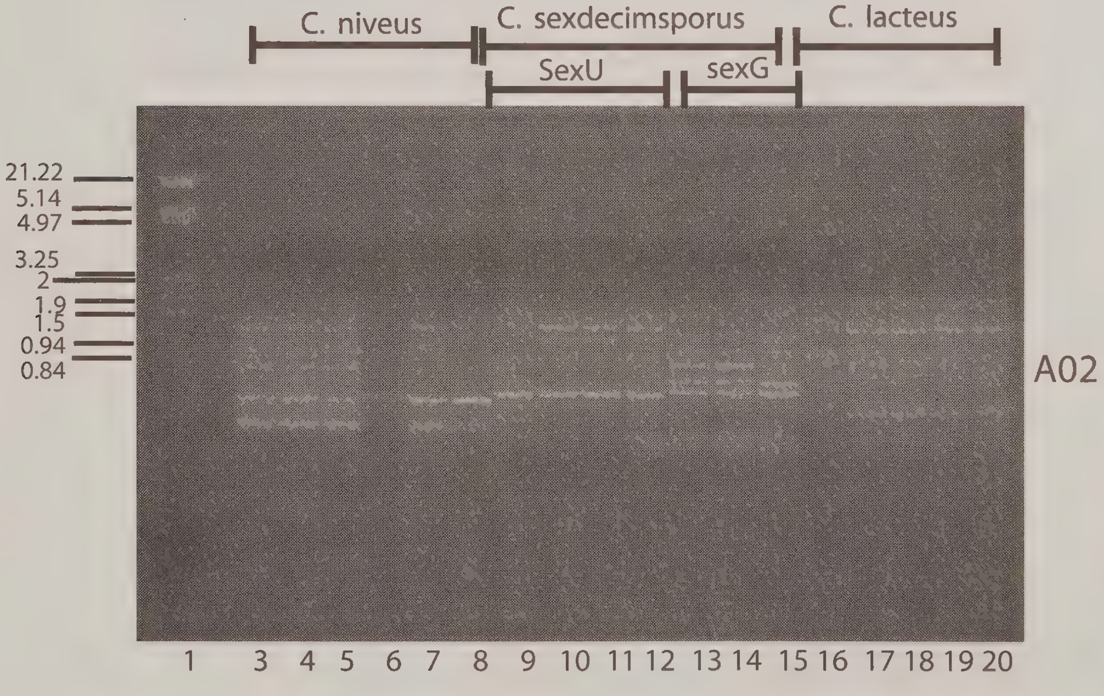

Figure 1. Amplification products generated with primer A02 in *Coprotus* species. Lane 1. Lambda DNA digested with EcoRI /HindIII used as molecular weight marker. Lanes 3-8: Strains of *C. niveus;* Lanes 9-15: Strains of *C. sexdecimsporus;* Lanes 16-20: Strains of *C. lacteus.*

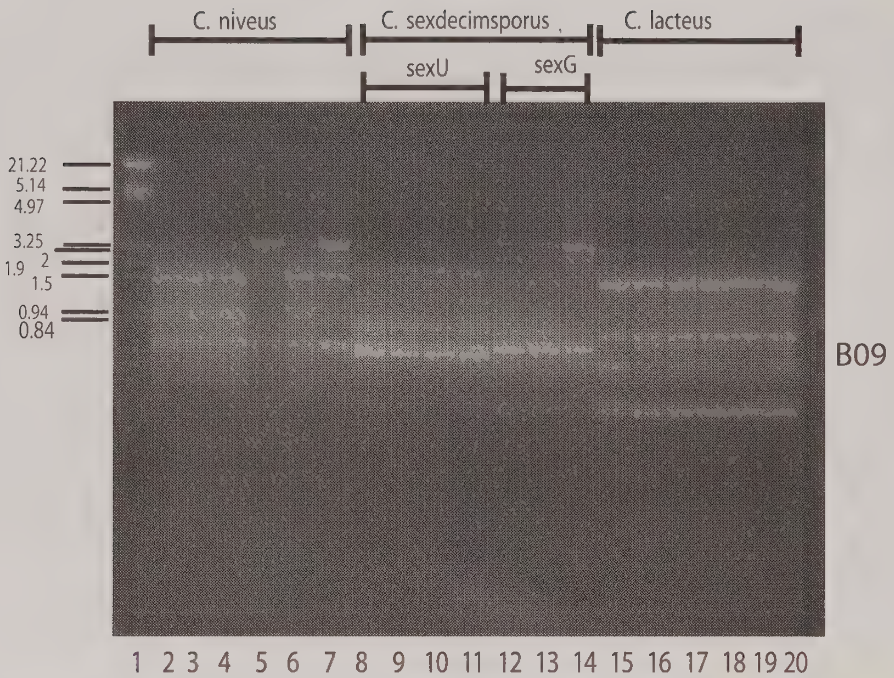

Figure 2. Amplification products generated with primer B09 in *Coprotus* species. Lane 1: Lambda DNA digested with EcoRI/HindIII used as molecular weight marker; Lanes 2-7: Strains of *C. niveus;* Lanes 8-14: Strains of *C. sexdecimsporus;* Lanes 15-20: Strains of *C. lacteus.*

All the species were characterised by band combinations. Twenty-six bands provided a reliable tool for the identification of the species studied in this paper (Table 2). Bands A02-2, A02-4, A02-11, B08-1, B09-2, B09-6′, B09-11, B10-11, B10-12 and B10-14 were present in all the strains of *C. lacteus* and absent in *C. niveus* and *C. sexdecimsporus*. Bands A02-14, A02-17, A10-2, A10-9, A10-10. B09-4, B09-6, B10-4, B10-9 and B10-10 were observed in strains of *C. niveus* and absent in *C. lacteus* and *C. sexdecimsporus*. Bands A2-13, A02-18, A02-19, A10-5, A10-11 and B08-3 were present in *C. sexdecimsporus* and absent in *C. lacteus* and *C. niveus*.

Genetic variability within species, measured in terms of percentage of polymorphic loci was low, being *C. sexdecimsporus* (P = 25%) and *C. niveus* (P = 17 %) the most variable species, and *C. lacteus* the least variable (P = 14%).

Genetic distance and cluster analysis

RAPD patterns of strains of each geographical group within species were almost identical for *C. lacteus* and *C. niveus*. This was reflected in the low genetic distances among geographical groups within each species (D = 0.03 between *C. lacteus* geographic groups and D = 0.02-0.03 between *C. niveus* geographic groups). In contrast, *C. sexdecimsporus* showed the highest genetic distance (D = 0.4) among geographical groups (Table 3).

Genetic distances among species were high (D = 0.68 between *C. lacteus* and *C. sexdecimsporus* and D= 0.75 between *C. niveus* and the cluster formed by *C. lacteus* and *C. niveus*). The phenogram obtained by means of UPGMA

Table 2. Distribution of RAPD species-specific bands in *Coprotus* using primers (A02, A10. B8, B9, B10) across nine geographical groups (OTUs).

Bands	*C.* LACTEUS		*C.* SEXDEC.		*C.* NIVEUS				
	lac A	lac L	sex G	sex U	niv U	niv C	niv BC	niv L	niv E
A02-2	+	+	-	-	-	-	-	-	-
A02-4	+	+	-	-	-	-	-	-	-
A02-11	+	+	-	-	-	-	-	-	-
A02-13	-	-	+	+	-	-	-	-	-
A02-14	-	-	-	-	+	+	+	+	+
A02-17	-	-	-	-	+	+	+	+	+
A02-18	-	-	+	+	-	-	-	-	-
A02-19	-	-	+	+	-	-	-	-	-
A10-2	-	-	-	-	+	+	+	+	+
A10-5	-	-	+	+	-	-	-	-	-
A10-9	-	-	-	-	+	+	+	+	+
A10-10	-	-	-	-	+	+	+	+	+
A10-11	-	-	+	+	-	-	-	-	-
B08-1	+	+	-	-	-	-	-	-	-
B08-3	-	-	+	+	-	-	-	-	-
B09-2	+	+	-	-	-	-	-	-	-
B09-4	-	-	-	-	+	+	+	+	+
B09-6	-	-	-	-	+	+	+	+	+
B09-6’	+	+	-	-	-	-	-	-	-
B09-11	+	+	-	-	-	-	-	-	-
B10-4	-	-	-	-	+	+	+	+	+
B10-9	-	-	-	-	+	+	+	+	+
B10-10	-	-	-	-	+	+	+	+	+
B10-11	+	+	-	-	-	-	-	-	-
B10-12	+	+	-	-	-	-	-	-	-
B10-14	+	+	-	-	-	-	-	-	-

*+ = presence - = absence

Table 3. Nei´s genetic distances between geographical groups.

	lacL	lacA	sexG	sexU	nivU	nivE	nivC	nivL	nivBC
lacL	0.00								
lacA	0.03	0.00							
sexG	0.63	0.62	0.00						
sexU	0.74	0.73	0.40	0.00					
nivU	0.73	0.72	0.64	0.78	0.00				
nivE	0.77	0.74	0.62	0.77	0.02	0.00			
nivC	0.82	0.80	0.67	0.80	0.02	0.02	0.00		
nivL	0.78	0.75	0.63	0.78	0.02	0.01	0.01	0.00	
nivBC	0.79	0.77	0.65	0.79	0.02	0.01	0.01	0.00	0.00

method (Figure 3) showed that all the strains were grouped into three defined clusters, which represented the three species analysed.

These clusters were highly supported by the analysis of consensus of 100 trees obtained from 100 bootstrapped pseudoreplicates of the original data

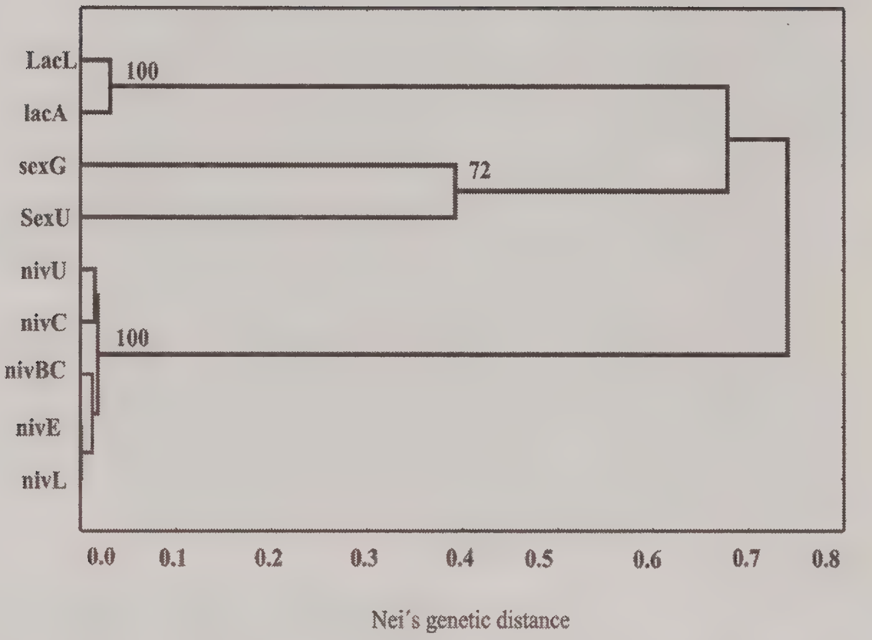

Figure. 3. UPGMA tree showing relationships of *Coprotus* species on the basis of Nei´s genetic distance estimated from RAPD loci. Number over branches represents bootstrap for each node.

matrix. The two clusters involving *C. lacteus* and *C. niveus* geographical groups showed 100% bootstrap support and the third cluster of *C. sexdecimsporus* geographical groups showed a value of 72 % (Figure 3).

Discussion

In a previous isozyme study, Suárez et al. (2006) observed low isozyme variability within species of the genus *Coprotus* by studying eleven isozyme systems. In this paper a high number of RAPD bands were analysed, which confirmed earlier results. The high intraspecific homogeneity detected by biochemical (Suárez et al. 2006) and RAPDs markers could be related to the fact that *Coprotus* is homothallic and produces clonal offspring (Rayner 1994). Anderson et al. (1992) stated that fungi have a wide array of reproductive strategies, which have an impact on their genetic variability. Therefore, measure of genetic diversity could be a potential indicator of the relative abundance of sexual and asexual reproduction (Chen & McDonald 1996). While high genetic variability was described for fungal species with sexual reproduction (Wang et al. 1997), low genetic polymorphism was found in species with asexual reproduction (Zeigler et al. 1995).

In non-out crossing type (homothallic) of a haploid organism, polymorphism could be the consequence of different evolutionary forces. Mutation and natural selection could lead to genetic divergence and therefore increase genetic variability levels in the homothallic (non-out crossing populations). In *Coprotus* species, RAPD patterns of strains of the same geographical groups were almost identical, which could support the hypothesis that time was not enough to allow differentiation.

Another interesting result is that RAPD technique provided twenty-six RAPD bands that were useful to recognise the species. This result contrasts with previous isozyme studies (Suárez et al. 2006), where ALP was the only system that showed a diagnostic electromorph for each species. Moreover, RAPD have a better ability to differentiate species than isozymes because they allow an extensive random sampling of the genoma providing a great number of DNA markers and therefore a higher number of species specific markers.

The difference between isozyme and RAPD markers was also reflected in the phenograms that represent phenetic relationships among species. Although in both phenograms all strains of the same species are grouped into three defined clusters, some disagreements can be observed. While the phenogram obtained from isozymes datasets (Suárez et al. 2006) showed a higher association between *C. niveus* and *C. lacteus* species, which is consistent with the morphologic similarity, in the present RAPD tree *C. lacteus* and *C. sexdecimsporus* are joined in a cluster, which is linked to *C. niveus*. This disagreement might be related to the different nature of these markers. RAPDs are usually considered neutral markers without known physiological function, whereas an adaptative significance of isozyme and morphological characters can not be ruled out because they are exposed to selective pressure.

Previous isoenzymatic studies (Suárez et al. 2006) showed a low intraspecific variability and characterized the *Coprotus* species by some isoenzymatic bands. In this paper, RAPD technique both effectively differentiated three *Coprotus* species by providing a greater number of species specific bands and confirmed the low isoenzymatic intraspecific variability.

This technique may therefore be considered a powerful and reliable taxonomic tool to add to traditional morphological and isozyme analytical methods.

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Literature cited

Anderson JB, Kohn LM, Leslie JF. 1992. Genetic mechanism in fungal adaptation. In: Carroll GC, Wicklow DT, eds. The Fungal Community: Its Organization and Role in the Ecosystem. Marcel Dekker, New York, USA: 73–98.

Aufauvre-Brown A, Cohen J, Holden DW. 1992. Use of randomly amplified polymorphic DNA markers to distinguish isolates of *Aspergillus fumigatus*. J. Clin. Microbiol. 30: 2991–2993.

Black IV WC. 1996. FORTRAN Programs for the Analysis of RAPD-PCR Markers in Populations. Colorado State University, Ft. Collins, CO.

Chen RS, McDonald BA. 1996. Sexual reproduction plays a major role in the genetic structure of populations of the fungus *Mycosphaerella graminicola*. Genetics 142: 1119–1126.

Cooke DEL, Kennedy DM, Guy DC, Russell J, Unkles SE, Duncan JM. 1996. Relatedness of Group I species of *Phytophthora* as assessed by randomly amplified polymorphic DNA (RAPD) and sequences of ribosomal DNA. Mycol. Res. 100: 297–303.

Crowhurst RN, Hawthorne BT, Rikkerink EHA, Templeton MD. 1991. Differentiation of *Fusarium solani* f. sp. *cucurbitae* races 1 and 2 by random amplification of polymorphic DNA. Curr. Gen. 20: 391–396.

Dellaporta SL, Wood J, Hicks JB. 1983. A plant DNA preparation: version ii. Plant Mol. Biol. Rep. 1: 19–21.

Doherty KR, Zweife LEW, Elde NC, McKone MJ, Zweifel SG. 2003. Random amplified polymorphic DNA markers reveal genetic variation in the simbiotic fungus of leaf-cutting ants. Mycologia 95: 19–23.

Felsenstein J. 1993. PHYLIP (Phylogeny Inference Package) V.3.5 Department of Genetics, The University of Washington, Seatle, WA.

Frazzon APG, Matsumura ATS, Van Der Sand ST. 2002. Morphological characterization and genetic analysis of *Drechslera teres* isolates. Gen. Mol. Biol. 25: 235–241.

Glienke-Blanco C, Aguilar-Vildoso CI, Carneiro Vieira ML, Vianna Barroso PA, Azevedo JL. 2002. Genetic variability in the endophytic fungus *Guignardia citricarpa* isolates from citrus plants. Gen. Mol. Biol. 25: 251–255.

Jacobson KM, Miller OK, Turner BJ. 1993. Randomly amplified polymorphic DNA markers are superior to somatic incompatibility test for discriminating genotypes in natural populations of the ectomycorrhizal fungus *Suillus granulatus*. Proc. Natl. Acad. Sci. USA 90: 9159–9163.

Kimbrough JW, Korf RP. 1967. A synopsis of the genera and species of the tribe *Thelebolaceae* (= *Pseudoascobolaceae*). Am. J. Bot. 54: 9–23.

Kimbrough JW, Luck-Allen ER, Cain RF 1972. North American species of *Coprotus* (*Thelebolaceae: Pezizales*). Can. J. Bot. 50: 957-971.

Khush RS, Becker E, Wach M. 1992. DNA amplification polymorphisms of the cultivated mushroom *Agaricus bisporus*. Appl Environ Microbiol. 58: 2971–2977.

McDonald BA 1997. The population genetics of fungi: tools and techniques. Phytopathology 87: 448–453.

Maclean DJ, Braithwaite KS, Manners JM, Irwing JAG. 1993. How do we identify and classify fungal pathogens in the era of DNA analysis? Adv. Plant. Pathol. 10: 207–244.

Mills PR, Sreenivasaprasad S, Brown AE. 1992. Detection and differentiation of *Colletotrichum gloeosporioides* isolates using PCR RAPD bind patterns of *Colletotrichum* iolates from banana from Australia. FEMS Microbiol Lett 98: 137–144.

Nei M. 1978. Estimation of average heterozygosity and genetic from a small numbers of individuals. Genetics 89: 583–590.

Ranalli ME, Forchiassin F. 1974. Estudio sistemático y biológico de las Ascoboláceas de Argentina V. Bol. Soc. Argent. Bot. 15: 427-445.

Rayner AD. 1994. Evolutionary processes affecting adaptation to saprotrophic life styles in ascomycete populations. In: Hawsksworth DL ed. Ascomycete Systematics. Problems and Perspectives in the Nineties NATO ASI series. Plenum Press, USA. 261–271.

Smith ML, Bruhn JN, Anderson JB. 1992. The fungus *Armillaria bulbosa* is among the largest and oldest living organisms. Nature 356: 428–431.

Statsoft, Inc. 2001. STATISTICA (data analysis software system), version 6. www.statsoft.com.

Suárez ME, Ranalli ME, Dokmetzian DA, Ramos AM 2006. Characterization of three species of the genus *Coprotus* (*Ascomycota*) by isozyme analysis. Mycotaxon 97: 257-273.

Vaillancourt LJ, Hanau RM. 1992. Genetic and morphological comparisons of *Glomerella* (*Colletotrichum*) isolates from maize and from sorghum. Exp. Mycol. 16: 219–229.

Wang XR, Ennos RA, Szmid AE, Hansson P. 1997. Genetic variability in the canker pathogen fungus G*remmeniella abietina*. 2. Fine-scale investigation of the population genetic structure. Can. J. Bot. 75: 1460–1469.

Williams JGK, Kubelik AR, Rafalski JA, Tingey SV. 1990. DNA polymorphism-amplified by arbitrary primers are useful as genetic markers. Nuc. Ac. Res. 18: 6531–6535.

Wicklow DT. 1981. The coprophilous fungal community: A mycological system for examining ecological ideas. In: Wicklow DT, Carroll GC. eds. The Fungal Community: Its Organization and Role in the Ecosystem. Marcel Dekker, USA: 47-76.

Wicklow DT, Detroy RW, Adams S. 1980. Differential modification of the lignin and cellulose components in wheat straw by fungal colonist ruminant dung: ecological implications. Mycologia 72: 1065–1076.

Yoon CS, Glawe DA. 1993. Association of random amplified polymorphic DNA markers with stromatal type in *Hypoxylon truncatum* sensu Miller. Mycologia 85: 369–380.

Zeigler RS, Cuoc LX, Bernardo MA, Chen DH, Valent B, Nelson RJ. 1995. The relationship between lineage and virulence in *Pyricularia grisea* in the Philippines. Phytopathology 85: 443–451.

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Alternaria roseogrisea, a new species from achenes of *Helianthus annuus* (sunflower)

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Abstract — *Alternaria roseogrisea* was isolated from the achenes of *Helianthus annuus* during studies conducted in 1983-85 to document the diversity of fungi occurring in sunflower seeds and the possible role these fungi play in degradation of oilseed quality. *A. roseogrisea* was reported as "*Alternaria* sp. 2" in this early study because there were no published descriptions in *Alternaria* to accommodate it, a deficiency that has persisted. More recently, cluster analyses of combined RAPD, RAMS (microsatellite) and AFLP fingerprints support the placement of *A. roseogrisea* within the *A. infectoria* species-group sensu Simmons and its segregation from other members of this group. *A. roseogrisea* is known only from high-quality oil-type sunflower seed, and is recognized by the grayish-pink color of mature colonies on 6% NaCl-tomato juice agar and the striking appearance of the very small, often one or two-celled conidia separated by secondary conidiophores that can be many times the length of and nearly as wide as the conidia themselves.

Key words — hyphomycetes, sporulation pattern, *Alternaria infectoria*

Introduction

During studies of fungi occurring in the achenes of *Helianthus annuus* L. in 1983-85, an unusual *Alternaria* was regularly isolated from samples of high-quality oilseed-type sunflower achenes that originated from the upper Midwestern U.S.A. An expert opinion on the identity of this fungus was sought from Dr. E. G. Simmons, who indicated it was representative of an undescribed taxon among a group of undescribed taxa that were *Alternaria* anamorphs of *Pleospora* (personal communication). Barr & Simmons subsequently described *Lewia* M.E. Barr & E.G. Simmons to accommodate those *Pleospora* species with small ascomata and ascospores and (where known) *Alternaria* anamorphs (Simmons, 1986b). Now, some 21 years later, description of this interesting and unusual fungus resolves a lingering deficiency in our knowledge of *Alternaria* species from *Helianthus*.

Materials and methods

Conditions of isolation, culture and observation

During 1983-85, isolates of *A. roseogrisea* were obtained with ease and regularity from samples of Grades No. 1 and No. 2 sunflower seeds that originated in the upper Midwestern U.S., which were provided by the U.S. Department of Agriculture, Federal Grain Inspection Service. Sunflower achenes were surface disinfested and plated onto 6% sodium chloride-tomato juice agar (TJ) as described previously (Roberts et al. 1986). Representative isolates were preserved as lyophilized conidial suspensions held at -20 C. The media, methods and conditions for growth and observation of *Alternaria* follow those described in pages 136-137 in Simmons & Roberts (1993). Three isolates, RGR 85.0034, RGR 85.0035 and RGR 85.0036, were revived onto potato carrot agar (PCA, Simmons & Roberts, 1993) and incubated under standardized conditions for *Alternaria* (25 C under cool white fluorescent lighting, 8 hr/16 hr of light/dark, Simmons & Roberts, 1993) until growth reached the edges of the plates and sporulation was evident. Cultures were examined at 50x using a stereoscopic microscope to assess the pattern of sporulation, then double-stick tape was pressed onto the colony surface and then mounted spore side up in several drops of lactic acid on a microscope slide for observation at higher magnifications. Microscopic morphology was recorded digitally using a Zeiss Axiocam Mr5a camera and a Zeiss Axioplan microscope. Color references in the taxonomic descriptions are to the corresponding color plates in the Methuen Handbook of Colour (Kornerup & Wanscher, 1989).

Molecular analysis

Cultures were grown and DNA prepared for analysis by the methods reported previously (Roberts et al. 2000 and Roberts, 2007). Methods and conditions for analysis of RAPD, RAMS and AFLP fingerprints followed Roberts et al. (2000) and Roberts (2007), to which the reader is referred for details.

Taxonomic Description

Alternaria roseogrisea R.G. Roberts **sp. nov.** Fig. 1

MycoBank MB 511161

Etym.: *rosea* - pink; + *grisea* - gray

Ex cultura in agaro PCA descripta. Colonia tempore diei septem ca 60 mm diam, inconspicue concentrice zonata, Centrum coloniae atrogriseum, granulosum, sporulatione densissima; area peripherica coloniae griseoviridis. Hyphae aeriae funiculosae in strato minus quam 1 mm crasso. Conidiophora primaria plerumque lateralia ex hyphis aeriis, solitaria, 25-210 x 4-4.8 µm, plerumque ramosa, geniculata. Conidia globosa vel subcylindrica, solitaria vel catenulata, 4.8-38.4 x 3.2-18.7 µm, in catenis pseudorostrata. Conidia minima globosa, eseptata vel 1-2 transverse septata; conidia subcylindrica plerumque transeptata. Conidia maxima ellipsoidea vel obpyriformibus, 5(-7) transverse septata et septis longitudinalibus

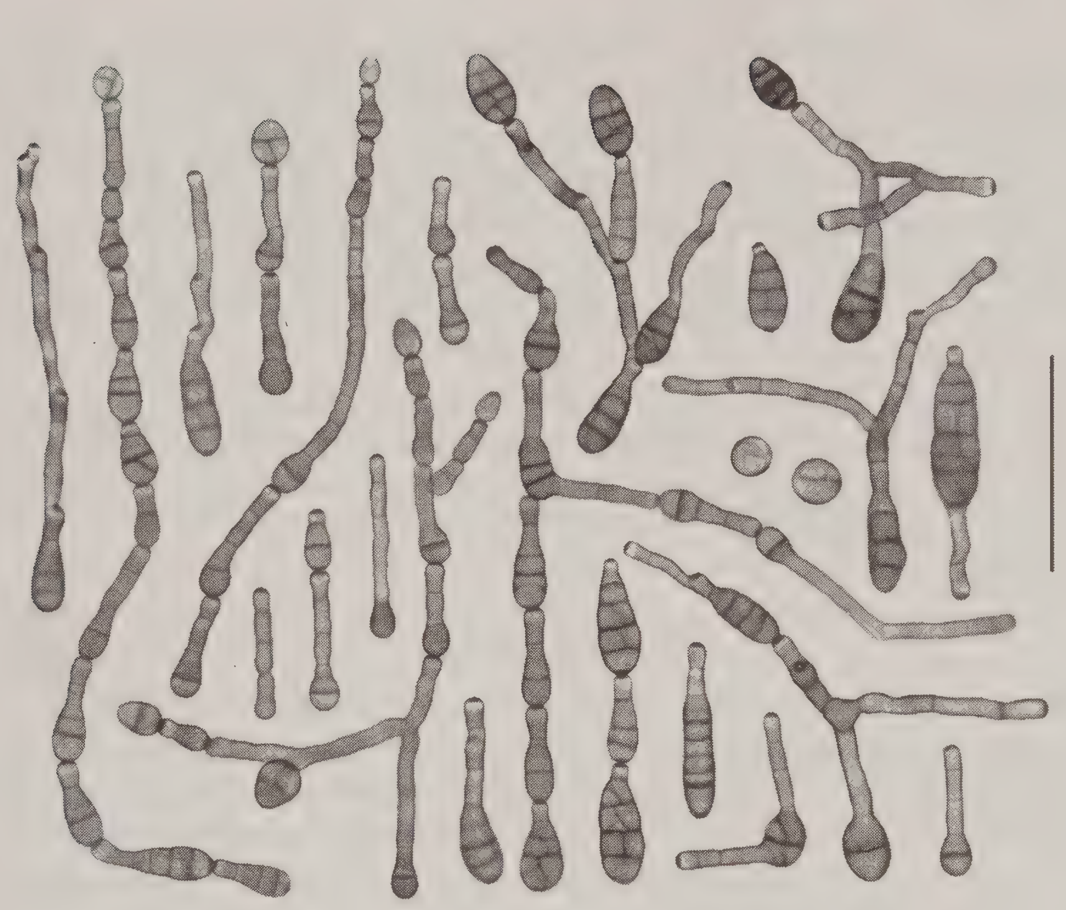

Fig.1. Conidia of *A. roseogrisea* from PCA. *Bar = 50* µm

vel obliquis numeris varialibus. Conidiophora secundaria ex corpore conidiorum apicalibus vel lateralibus, 3.2-160 x 3.6-9.8 µm, saepe apice amplificato. Corpus conidiorum laeve vel punctatum, saepe verrucosum.

Description from cultures grown on PCA for 7 days at 25 C and 21% relative humidity. Colonies about 60 mm diam., faintly and concentrically zonate. Sporulation most dense in center of colony, which is granular in appearance, centrally dark gray (1F1) to grayish green (1D4) at the outer portions of the colony. Primary conidiophores are 25-210 x 4-4.8 µm, mononematous, frequently branched, geniculate, developing predominantly as lateral branches from funiculose aerial hyphal elements that form a low turf less than 1 mm tall. Conidia globose to subcylindrical, solitary to catenulate, pseudorostrate when catenulate, 4.8-38.4 x 3.2-18.7 µm. Spore bodies are smooth to punctate, frequently verrucose. The smallest conidia are globose and aseptate or with 1-2 transverse septa. Subcylindrical conidia are predominantly transversely septate. The largest conidia are ellipsoid to obpyriform, with up to 5(-7) transverse septa and variable numbers of longitudinal septa and oblique septa. Secondary conidiophores develop apically or laterally from conidium bodies, 3.2-160 x

3.6-9.8 µm, frequently with an enlarged apex, especially when produced from globose conidia. When grown on TJ for 7 days, colonies are low, plane to faintly sulcate, with indistinct concentric zonation present in older portions but absent from areas of recent growth. Colonies of *A. roseogrisea* RGR 85.0036 on TJ are ca 59 mm diam, and the dull red (10B3, outer colony) to grayish brown (10F3, inner colony) color of the colony is the character for which the species is named and the reason for prior reference to *A. roseogrisea* as the "pink" *Alternaria* (Roberts et al. 1986).

Type (holotype): BPI 878240; (dried culture preparation ex RGR 85.0036, isol. Roberts from an achene of oil-type *Helianthus annuus*, Athens, GA, 1984; origin of achenes from U.S. Department of Agriculture, Federal Grain Inspection Service, North Dakota, USA. Ex-type culture deposited at Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands as CBS 121921.

Discussion

Roberts et al. (1986) reported a relative frequency of isolation of 0.012 for *A. roseogrisea* (as *Alternaria* sp. 2, "pink") from more than 28,000 oilseed-type sunflower achenes assayed. Assays of confectionery-type sunflower achenes during and after development in experimental plots in Georgia did not yield any isolates of *A. roseogrisea.* It may be inferred from this admittedly limited sampling that the distribution of *A. roseogrisea* is limited to sunflower production areas in the upper Midwestern U.S., but it would likely also be encountered in other temperate sunflower production areas (mostly between 45° and 50° N latitudes). The occurrence of *A. helianthinficiens* E.G. Simmons et al. in sunflower achenes from production areas in the U.S. and Europe supports this conjecture (Simmons, 1986a). *A. roseogrisea* is not known to be associated with any disease symptom of sunflower, and was associated by Roberts et al. (1986) with higher-quality seed samples (low free fatty acids and high germination percentages).

In Roberts (2007, Fig. 4), the dendrogram representation of a combined cluster analysis of RAPD, RAMS and AFLP fingerprints of *Alternaria* strains belonging in the *A. infectoria* species-group (Simmons & Roberts, 1993) showed the ex-type isolate of *A. incomplexa* E.G. Simmons clustered with isolate RGR 85.0034 of *A. roseogrisea (*as *Alternaria* sp. from *Helianthus annuus).* The central cluster in Fig. 4 contains three isolates of *A. arbusti* E.G. Simmons including the ex-type isolate, three isolates of *A. roseogrisea* including the ex-type isolate, and the *A. incomplexa* isolate. All three species are resolved within this central cluster save *A. incomplexa*, although inclusion of additional isolates of *incomplexa* in the analysis might reasonably be expected to pull RGR 96.0013 into an 'incomplexa' cluster. A similar situation was noted and discussed by Roberts et al. (2000), who presented a cluster analysis of a subset (28 isolates, Fig. 4) of the 260 isolates used (Fig. 3). In the analysis of the 28-isolate subset, *A. arbusti* clustered with *A. gaisen* but when analyzed among all 260 isolates, which contained additional representative isolates, *A. arbusti* and *A. gaisen* Nagano were fully resolved. Roberts et al. (2000) therefore cautioned against "... inferring relationships between strains from RAPD fragment patterns because the topologies of the dendrograms from cluster analyses are influenced by the number of isolates and the representation within the group". Given that the present analysis is also a cluster analysis of a relatively small data set (e.g., a single isolate for *A. incomplexa*), a similar caution applies here. It is unfortunate that additional isolates of *A. incomplexa* were not available for analysis.

The author considers the inclusion of *A. incomplexa* in a cluster of *A. roseogrisea* isolates to be an artifact of sample size for reasons stated. As such, the current results do not qualify the conclusion that *A. roseogrisea* is recognizably distinct from other members of the *A. infectoria* species-group or the hundreds of isolates from all species-groups that have been studied over the years, and no practitioner with access to authenticated cultures of *A. roseogrisea* and *A. incomplexa* would have difficulty distinguishing between them. That *A. arbusti*, *A. roseogrisea* and *A. incomplexa* would cluster together is neither illogical nor problematic, as they are all representatives of the *A. infectoria* species-group. *A. roseogrisea* and *A. incomplexa* both produce a high percentage of spores that are relatively small for the genus and other members of the *A. infectoria* species-group; the smallest of the conidia typically exhibit 0-3 transverse septa and typically lack longitudinal septa. Similarly, although conidia of *A. arbusti* are larger and more robust than conidia of either *A. incomplexa* or *A. roseogrisea*, the pattern of relatively unbranched sporulation is among the simplest encountered in the *A. infectoria* species-group. *A. incomplexa* differs from *A. roseogrisea* in several characters (Simmons 1996), including larger and more ellipsoidal conidia and development of primary conidiophores from surface or subsurface hyphal elements versus aerial elements in *A. roseogrisea*.

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Literature cited

Kornerup A, Wanscher JH. 1989. Methuen Handbook of Colour, 3rd ed. Methuen: London (UK). 252 pp.

Roberts RG. 2007. Two new species of *Alternaria* from pear fruit. Mycotaxon 100: 159-167.

Roberts RG, Reymond ST, Andersen B. 2000. RAPD fragment pattern analysis and morphological segregation of small-spored *Alternaria* species and species-groups. Mycol. Res. 104:151-160.

Roberts RG, Robertson JA, Hanlin RT. 1986. Fungi occurring in the achenes of sunflower (*Helianthus annuus*). Can. J. Bot. 64: 1964-1971.

Simmons EG. 1986a. *Alternaria* Themes and Variations (17-21). Mycotaxon 25: 203-216.

Simmons EG. 1986b. *Alternaria* Themes and Variations (22-26). Mycotaxon 25: 287-308.

Simmons EG. 1996. *Alternaria* Themes and Variations (145-149). Mycotaxon 57: 391-409.

Simmons EG, Roberts RG. 1993. *Alternaria* Themes and Variations (73). Mycotaxon 48: 109-140.

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A new bluing species of *Psilocybe* (*Basidiomycota, Agaricales, Strophariaceae*) — the first record of section *Stuntzii* for Mexico

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Abstract — *Psilocybe meridionalis* is described as a new species from an oak-pine subtropical forest in the western mountains of the state of Jalisco, Mexico. Because of its bluing feature, annulus and subrhomboid basidiospores, this species belongs to section *Stuntzii*. The smaller spores and presence of pleurocystidia distinguish this species from the others in the section. This is the first record of a member of section *Stuntzii* from Mexico.

Keywords — new edition, *Psilocybe* monograph

Introduction

The genus *Psilocybe* has been studied in Mexico since the 1950's (e.g., Heim & Wasson 1958, Singer & Smith 1958) when hallucinogenic mushrooms were first revealed. It is likely that there are still undescribed species of *Psilocybe* as indicated by Guzmán (1998) and Guzmán et al. (2005). Moreover, in the state of Jalisco there have been few mycological explorations despite on-going mushroom research carried out by Guzmán-Dávalos for more than 20 years (e.g., Guzmán-Dávalos et al. 1983). In this paper, we describe a new species of *Psilocybe* made by Sánchez-Jácome in an oak-pine subtropical forest in the western mountains of Jalisco.

Materials and methods

Microscopic observations were made obtaining thin sections of the tissues of dried basidiomata. These sections were mounted in 5% NH_4OH, and 5%

KOH or with 1% Congo red solution previously treated with 96% alcohol for rehydrating. At least 25 measurements were taken of each microstructure, which was drawn with the aid of a light tube. Basidiospore sizes provided are length, width in face-view, and thickness in side-view.

Results

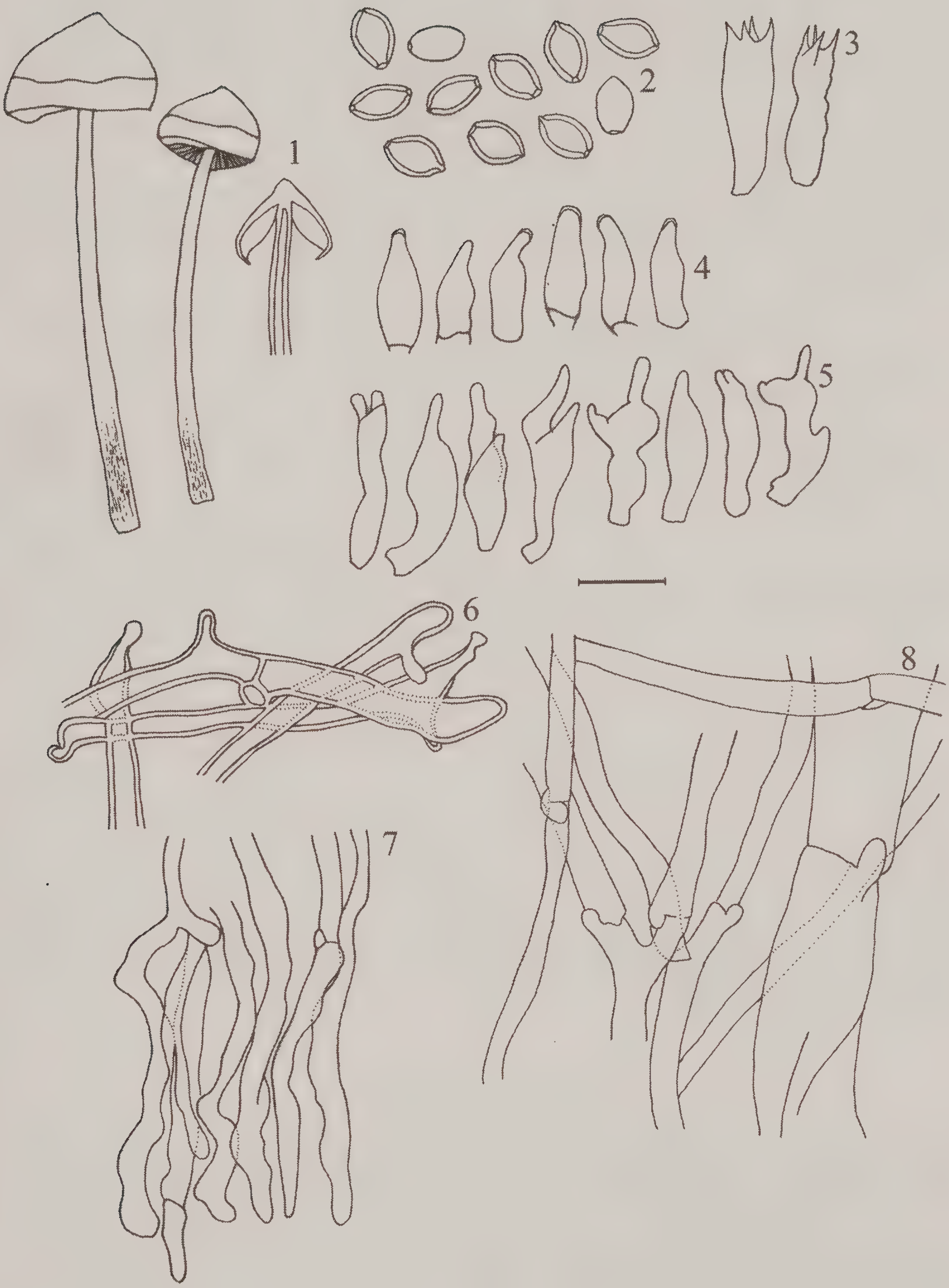
Psilocybe meridionalis Guzmán, Ram.-Guill. & Guzm.-Dáv., **sp. nov.** **Figs. 1-8**
MycoBank MB 511238

Etymology. From southern region, related to the austral distribution in the Tropic of Cancer, as opposed to the more northern (United States) distribution for other species in section *Stuntzii.*

Pileus 20-30(-40) mm latus, conicus vel campanulatus, glaber, rufobrunneus, hygrophanous, caerulescente. Lamellae adnate vel annexa, brunneus violaceous, marginis albidus, caerulescente. Stipes 85-100(-120) × 3-5 mm, concolor pileus, caerulescente. Annulus membranaceous, caerulescente. Sporae 6-7 (-8) × 4-5 × 4-5 µm, subrhomboideus vel subellipsoideus, pariete 1 µm crasis, brunneolus, poro germinali lato. Pleurocystidia 11-14 × 4-6 µm, hyaline, communis, ventricosus rostratus. Cheilocystidia 13-26 × 4-5.5 µm, hyaline, ventricosus rostratus, frequens ramus irregulariter. Pileipelles nullus gelatinous. Fibulae communis. Mexico, Jalisco, mountis Cacoma, prope Autlan, mensis september, Sánchez-Jácome 1163 (holotype IBUG).

Pileus 20–30(–40) mm diam., conical to campanulate, with a slight papilla, smooth, light to dark reddish-brown, hygrophanous, changing to dark beige, dry specimens chocolate-brown, highly caerulescent to blackish, margin entire, appendiculate. Lamellae adnate to adnexed, pinkish-brown to dark violaceous-brown, with whitish and finely floccose margin (observed with a lens), caerulescent. Stipe 85-100(-120) × 3-5 mm, smooth but slightly scaly toward the base, concolorous with the pileus, hollow, with subbulbous base. Veil well developed, as a thick membrane covering the lamellae, which leaves a membranous annulus on the stipe and/or remains on the margin of the pileus, caerulescent. Context whitish to brownish, caerulescent. Odor and taste not checked.

Basidiospores 6-7 (-8) × 4-5 × 4-5 µm, subrhomboid in face-view, subellipsoid in side-view, thick-walled, wall up to 1 µm thick, yellowish-brown, with a broad germ pore in one end and a short hilar appendage on the other. Basidia 16-22 × 4-5.5 µm, 4-spored, hyaline, variable from oblong to ventricose-clavate, with a median constriction. Pleurocystidia 11-14 × 4-6 µm, hyaline, common, but difficult to find, it is necessary to observe them with Congo red, ventricose-rostrate, apex prolongation short, frequently with a dark apex by the reaction of the Congo red. Cheilocystidia 13-26 × 4-5.5 µm, hyaline, forming a sterile edge, ventricose-rostrate, with a short or long apical prolongation, frequently irregularly branched or irregular in form. Subhymenium subcellular, elements



Figs. 1-8. *Psilocybe meridionalis*. **1**: basidiomata, **2**: basidiospores, **3**: basidia, **4**: pleurocystidia, **5**: cheilocystidia, **6**: setoid hyphae of the base of stipe, **7**: hyphae in the stipe context, **8**: hyphae of the veil (all from the holotype). Scale bar = 17 mm in 1, 10 µm in 2-8.

4-8 µm wide, hyaline. Hymenophoral trama regular, hyaline to yellowish in mass, hyphae 5-20 µm wide. Pileipellis a cutis, with postrate, hyaline hyphae, 2-3 µm wide, not gelatinous. Subpellis with hyaline to yellowish hyphae, 2-8 µm wide. Context of stipe with hyaline to pale yellowish hyphae, 3-14 µm wide. Setaceous hyphae in the base of stipe 4-5.5 µm wide, thick-walled, yellowish-brown. Clamp connections present. Veil formed by radially disposed, hyaline to grayish, thin-walled, branched hyphae, 1.5-4 µm wide.

Habitat and distribution—Gregarious on soil, in a subtropical *Quercus-Pinus* forest, close to tropical vegetation, at 2200 m alt. Known only from the type locality.

Specimen studied. **MEXICO, Jalisco**, Sierra Cacoma, Municipio Autlán, Neverías, Sept. 27, 2005, *Sánchez-Jácome 1163* (holotype IBUG, isotype XAL).

Discussion—The combination of the bluing basidioma, well developed veil and annulus, and subrhomboid, thick-walled basidiospores places *Psilocybe meridionalis* in section *Stuntzii* Guzmán, following the classification of Guzmán (1983, 1995). The smaller spores and the presence of pleurocystidia distinguish this species from other species in the section. It is probable that *P. meridionalis* has a pseudorhiza because the basidiomata studied had incomplete bases and the remaining ends may have buried in the clay soil. It is interesting to observe the highly caerulescent discoloring of the basidiomata on all parts. Also, it is important to note the setaceous hyphae in the base of the stipe. Although rare, these hyphae, have not been reported in any species of section *Stuntzii* until now, but such hyphae are present in several species of *Psilocybe* section *Cordisporae* (e.g., *P. guilartensis* Guzmán et al., *P. mesophylla* Guzmán et al., *P. oaxacana* Guzmán et al., *P. fagicola* R. Heim & Cailleux emend. Guzmán, and others, cf. Guzmán et al. 2003, 2004, 2005). This is the first record in Mexico of a species belonging to section *Stuntzii*. This species brings to 12 the number of *Psilocybe* species documented from Jalisco, nine of which have the bluing reaction (Guzmán 1998).

Acknowledgments

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Literature cited

Guzmán G. 1983. The genus *Psilocybe*. Beihefte Nova Hedwigia 74, Cramer, Vaduz.

Guzmán G. 1995. Supplement to the monograph of the genus *Psilocybe*. In: Petrini O, Horak E. Taxonomic monographs of *Agaricales*. Bibliotheca Mycologica 159, Cramer, Berlin. pp. 91-141.

Guzmán G. 1998. Las especies de *Psilocybe* conocidas de Jalisco (México) y descripción de dos nuevas para la ciencia. Acta Botánica Mexicana 43: 23-32.

Guzmán G, Escalona F, Ramírez-Guillén F, Jacobs JQ. 2004. New hallucinogenic mushrooms in Mexico belonging to the genus *Psilocybe*. International Journal of Medicinal Mushooms 6: 283-294.

Guzmán G, Jacobs JQ, Ramírez-Guillén F, Murrieta D, Gándara E. 2005. The taxonomy of *Psilocybe fagicola*-complex. Journal Microbiology (Korea) 43: 158-165.

Guzmán G, Tapia F, Ramírez-Guillén F, Baroni TJ, Lodge DL, Cantrell SA, Nieves-Rivera AM. 2003. New species of *Psilocybe* in the Caribbean, with an emendation of *P. guilartensis*. Mycologia 95: 1171-1180.

Guzmán-Dávalos L, Nieves G, Guzmán G. 1983. Hongos de Jalisco II. Especimenes depositados en el Herbario ENCB, 1ª. parte. Boletín de la Sociedad Mexicana Micología. 18: 165-182.

Heim R, Wasson RG. 1958. Les champignons hallucinogènes du Mexique. Archives Mus. Nat. d'Hist. Nat., Sér. 7, VI, Paris.

Singer R, Smith AH. 1958. Mycological investigations on teonanácatl, the Mexican hallucinogenic mushrooms II. A taxonomic monograph of *Psilocybe*, section *Caerulescentes*. Mycologia 50: 239-303.

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Taxonomic status and new localities for *Ganoderma ravenelii*

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Abstract—The taxonomic status of *Ganoderma ravenelii* is discussed; furthermore, the species is recorded from two new localities in the USA and probably from Mexico. A complete redescription and illustrations of the species are provided.

Key words— *Ganoderma curtisii*, *G. meredithiae*, North Carolina, Texas

Introduction

Based on the absence of resinous bands in the context and basidiospore shape and size, Steyaert (1980) described *Ganoderma ravenelii* from two collections originally from southern USA. The type specimen was previously identified as *G. curtisii* (Berk.) Murrill, a very closely related species. Steyaert himself (1980) suggested that both taxa might eventually represent just varieties of a single species. According to Moncalvo & Ryvarden (1997), the taxonomic status of these two species remain unclear.

G. ravenelii has not been reported since its original description, probably because it was erroneously determined as *G. curtisii* or as another species. Gilbertson & Ryvarden (1986) and Adaskaveg & Gilbertson (1988) mentioned neither *G. ravenelii*, nor *G. curtisii* in their monographs on polypores from North America.

In a reevaluation of the *Ganodermataceae* from Mexico during which the type of *G. ravenelii* was studied, Torres-Torres & Guzmán-Dávalos (2005 and unpublished data) suggested the presence of *G. ravenelii* in the area but could not establish the species with confidence because the available specimen was too immature. During a visit to the Chicago Field Museum Herbarium (F), collections labeled as *G. lucidum* or *Ganoderma* sp. but agreeing with Steyaert's description were found and studied in detail. In addition, specimens labeled as *G. curtisii* at F and IBUG were studied in order to compare the two species. Unfortunately, the type of *G. curtisii* could not be located at K or BR and so was not studied.

Critical analysis of the features that Steyaert (1980) used to delimit the two species support his conclusion of the presence of two different taxa. Here we provide a full description and illustrations of *G. ravenelii* and include additional features not considered by Steyaert. The species is recorded for the second time in the world from two new localities in the USA and probably from Mexico.

Materials and methods

All materials (except the *G. ravenelii* holotype obtained on loan from K) were studied at F and IBUG. Herbaria abbreviations follow Holmgren et al. (1990). The key colors are from Kornerup & Wanscher (1963). Micromorphologic observations were made from material mounted in 5% KOH. The basidiospore shape was determined from a Q coefficient (length-width; Bas 1969) from at least 20 randomly selected basidiospores from each collection. The drawings of the microscopic structures were made using a 100x oil-immersion objective on a Zeiss K7 or Zeiss Axioscop 40 microscope.

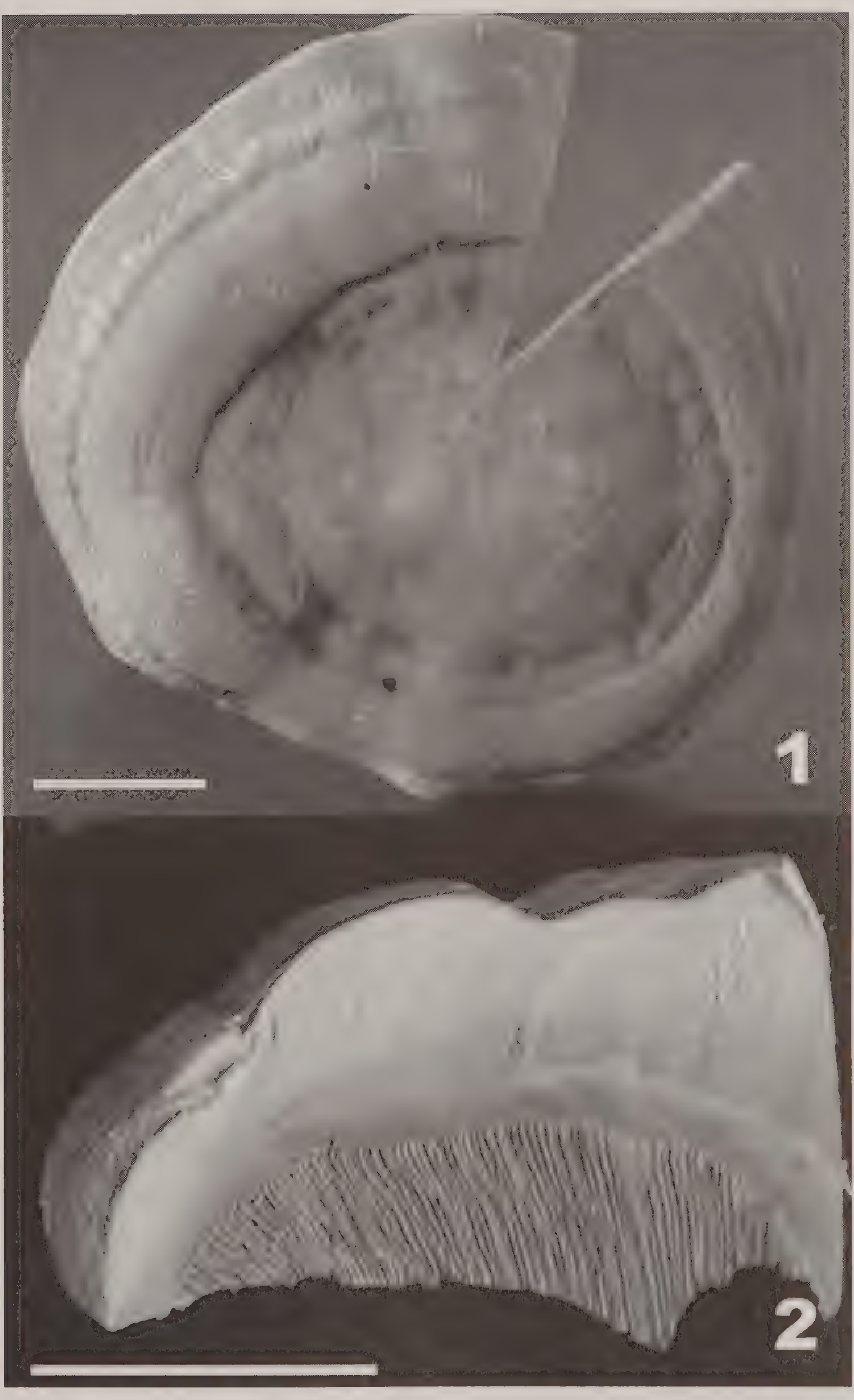
Taxonomy

Ganoderma ravenelii Steyaert,

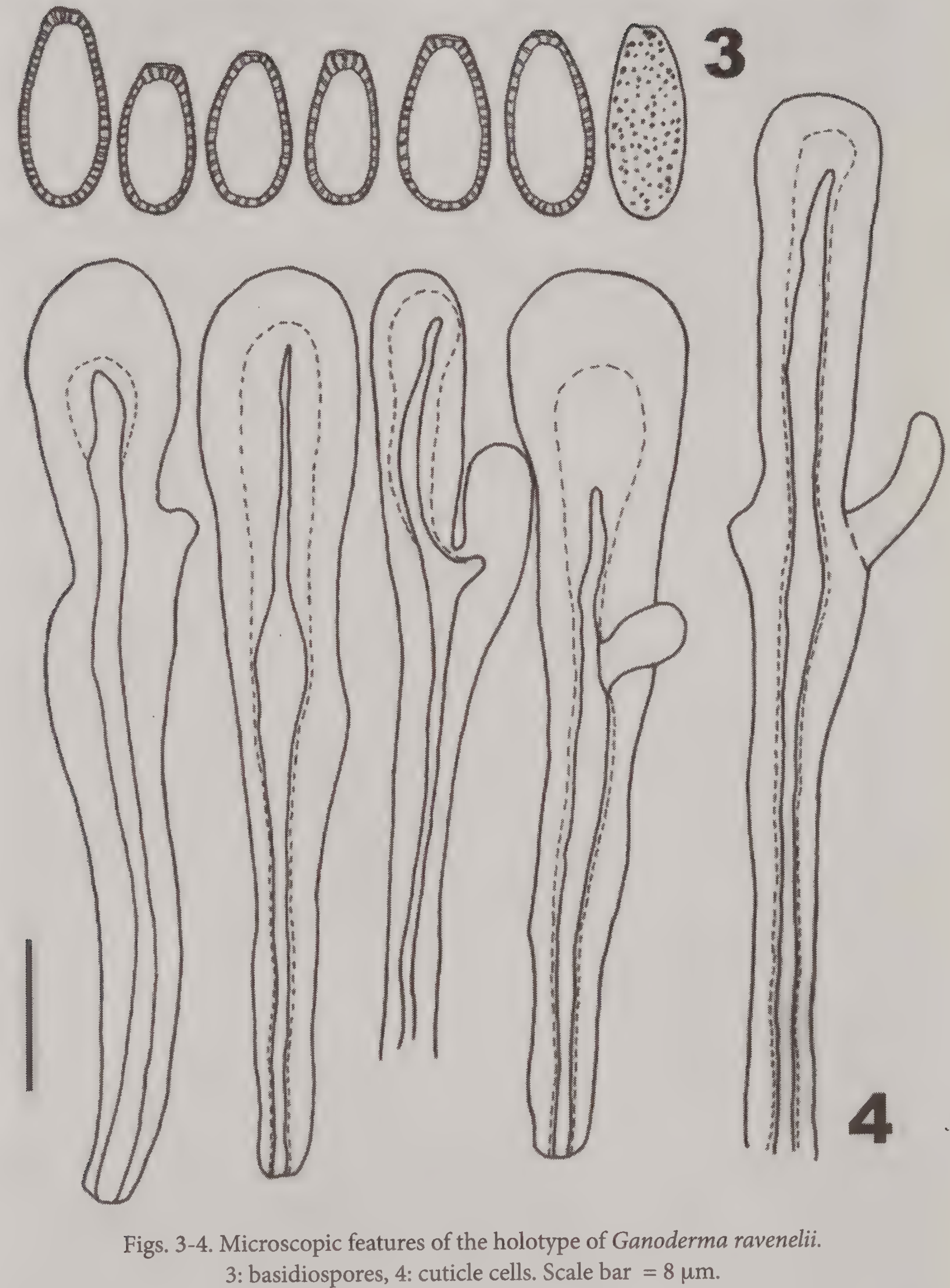
Bulletin du Jardin Botanique National de Belgique 50(1-2): 146, 1980. **Figs. 1-6**

BASIDIOMATA 4.8–6.7 × 3.9–4.5 × 1–1.5 cm, annual, stipitate, single, sometimes imbricate, corky to woody. PILEUS pleuro to mesopodal, rounded flabelliform, reniform to circular, upper surface slightly convex to plane; surface glabrous, smooth to slightly tuberculate, soft, semi-dull, occasionally shiny all over the surface, concentrically sulcate; with a laccate crust, easy to penetrate with fingernail, generally easily removed; maize (4A6), deep yellow (4A8), golden-yellow (5B8) to yellowish-brown (5C8), more or less homogeneous, or with zonations of these tones, occasionally covered by cinnamon (6D6) basidiospores; margin concolorous, entire, thick, rounded to truncate, smooth. STIPE 1-10 × 1.1-1.6 cm, eccentric to central, cylindrical to flattened, solid; surface smooth to tuberculate, dull to shiny, with a laccate crust, easy to remove or not, red-wine almost black, generally darker than pileus.

CONTEXT 0.7–1.3 cm thick, corky to slightly fibrous, duplex, azonate, pale orange to light orange (5A3, 5A4), brown-sienna (6D7) close to the tubes, without resinous bands. PORES 2–3 per mm, angular to rounded; pore surface

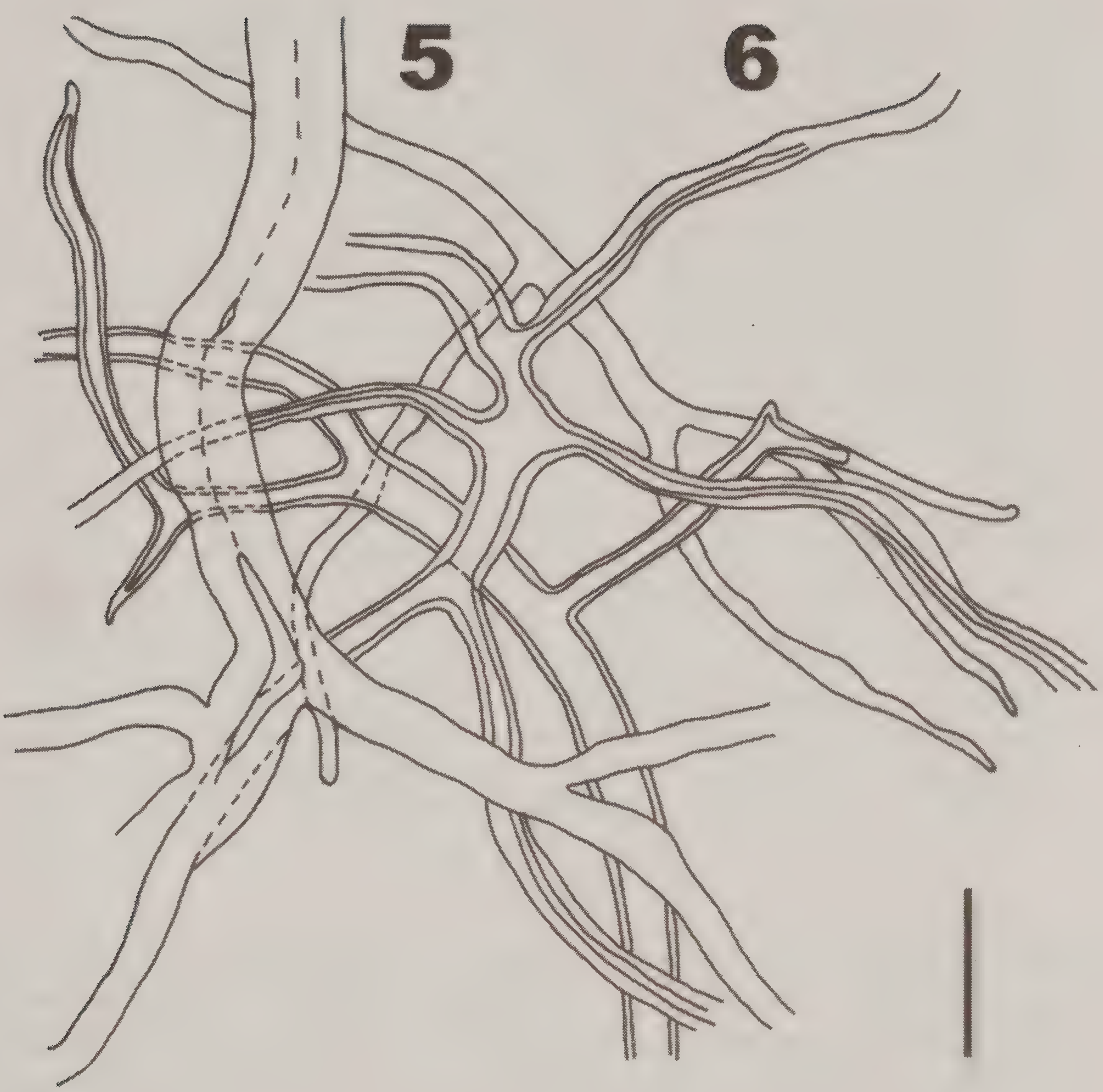


Figs. 1-2. Macroscopic features of *Ganoderma ravenelii* (D.P. Lewis 3428).
1: pileus, 2: context without resinous bands and tubes. Scale bar = 1 cm.



Figs. 3-4. Microscopic features of the holotype of *Ganoderma ravenelii*.
3: basidiospores, 4: cuticle cells. Scale bar = 8 µm.

yellow (2A3) to pale yellow (3A3), darkening to brown (6D8) when bruising or aging; tubes 0.5–1 cm long, unstratified, pale vinaceous-brown to vinaceous-brown (8E4). Hyphal system di-trimitic. Contextual trama with generative hyphae no observed; skeletal hyphae 3.2–8.8 µm diam., thick-walled to solid, non-septate, arboriform, yellowish to yellowish-brown, predominant; binding



Figs. 5-6. Microscopic features of the holotype of *Ganoderma ravenelii*.
5: skeletal hyphae, 6: binding hyphae. Scale bar = 8 µm.

hyphae 5.6–8.8 µm diam., thick-walled to solid, non-septate, yellowish. Hymenophoral trama as contextual trama. Pileipellis with cuticle cells 56–80 × 7.2–16 µm, broadly clavate, generally entire or with one lateral protuberance, thick-walled to solid, generally multistratified, yellowish, amyloid in Melzer's reagent; generative hyphae up to 4 µm diam., thin-walled, with conspicuous clamps, hyaline, difficult to observe; skeletal hyphae 4–6.4 µm diam., thick-walled to solid, non-septate, arboriform, yellowish to almost hyaline, scarce; binding hyphae 2–8 µm diam., thick-walled to solid, non-septate, yellowish to yellowish-brown. Basidiospores (10.2–) 10.8–15.2 × 5.2–7.2 µm, 12.4 × 6.1 µm on average, Q = 1.78–2.72, oblong to cylindrical, apex truncate, with apical germ pore, yellowish-brown; perisporium wrinkled, hyaline to yellowish-red; exosporium with inter-walled pillars up to 0.4 µm thick, free. Basidia not observed. Cystidia absent.

Specimens examined. **USA,** South Carolina, Aiken, on the ground, s. data, H.W. Ravenel 2936 (K, HOLOTYPE). Florida, Columbia, Camp O'Lena State Park, s. data, H.S. Dybas s.n. (F). North Carolina, Columbus Co., Reaves Ferry, on tree roots, 18 Oct 1934, W.C. Coker s.n. (F). Texas, Hardin, Larsen Preserve, 21 Dec 1982, D. P. Lewis 3428 (F). **MEXICO,** Jalisco, Municipality of San Cristóbal de la Barranca, km 17 road Guadalajara-San Cristóbal de la Barranca, Milpillas brook, oak forest with tropical influence, altitude 1460 m, 28 Jul 1987, C. Téllez 1025 (IBUG).

Specimens of *Ganoderma curtisii* examined. **USA,** North Carolina, Ardmore Woods, on old oak stump, 10 Aug 1932, P.O. Schallert s.n.; Columbus, Reaves Ferry, on tree roots, 18 Oct 1934, W.C. Coker s.n.; Forsyth, Winston-Salem, in yard, 30 Sep 1934, P.O. Schallert s.n.; Jackson, Whiteside Mt., 12 Jun 1934, P.O. Schallert s.n.; Durham, Durham Duke University Forest, on a stump, Aug 1949, W.L. Culberson s.n. Georgia, Thomas, Thomasville, 19 Jul 1947, H. Field s.n. Louisiana, Calcasieu, Lake Prien, on the ground in pine woods, 30 Oct 1948, F. Drouet s.n. Texas, Hardin, Big Thicket National Preserve, Lance Rosier Unit Cotton Road, on wood, 15 Jun 1983, D.P. Lewis 3515 (all in F). **MEXICO,** Jalisco, Municipality of Zapopan, Bosque La Primavera, 8 km from Prolongación Mariano Otero, oak forest, altitude 1500 m, 20 Jul 2004, M.G. Torres-Torres 526; La Primavera town, Avenida San Antonio, oak forest, altitude 1650 m, 20 Jul 2004, M.G. Torres-Torres 527; Municipality of San Cristóbal de la Barranca, Rancho Pericos, oak forest, altitude 1800 m, 24 Jul 2004, M.G. Torres-Torres 532, Municipality of Colotlán, 14.5 km road Colotlán-Carrizal, oak forest, altitude 1600 m, 2 Aug 2004, M.G. Torres-Torres 541; Municipality of Unión de Tula, Ejutla, near to San Gaspar, oak forest with *Bursera* sp. and *Acacia* sp., 24 Aug 2004, M.G. Torres-Torres 554 (IBUG).

Discussion

Macromorphologically, *Ganoderma ravenelii* is closely related to *G. curtisii* (Steyaert 1980, and see Table 1 below). Besides the features emphasized by Steyaert (1980) to separate *G. ravenelii* from *G. curtisii* (e.g., absence of resinous bands in the context, shape and size of basidiospores), other important features can be identified: union of the stipe with the pileus, basidiospore pillars, and cuticle cells (Table 1).

Ganoderma curtisii produces basidiomata with lateral or occasionally eccentric stipes, resinous bands in the context, cuticle cells that are occasionally laterally or apically branched, ellipsoid to oblong basidiospores [(9.2–)10.4–12(-13.6) × 5.6–8 μm, 11.2 × 6.6 μm on average] with pillars slightly thicker and subfree (free dots mixed with short anastomosed to shortly elongated structures). For *G. ravenelii,* Steyaert (1980) reported cuticle cells of 20 × 8–10 μm, surely a mistake, because his figure 7 shows other proportion. Both *G. curtisii* and *G. ravenelii* can co-exist in the same geographic area, but the morphological features distinguish them as separate species. Based on these morphological differences, we recognize *G. ravenelii* and *G. curtisii* as two distinct species. On the other hand, *G. meredithiae* Adask. & Gilb., another very closely related species (see Table 1), is differentiated by its obligate growth on pines and morphologically distinct cuticle cells (Adaskaveg & Gilbertson 1988).

TABLE 1. Morphologic features of *Ganoderma curtisii* and *G. ravenelii.*

SPECIES	*G. CURTISII*	*G. MEREDITHIAE**	*G. RAVENELII*
STIPE	generally lateral	sessile, or stipe central to lateral	eccentric to central
CONTEXT	duplex	relatively homogeneous or duplex (?)	duplex
RESINOUS BANDS	present	present	absent
BASIDIOSPORE SIZE	(9.2–)10.4–12(–13.6) × 5.6–8 μm, average 11.2 × 6.6 μm	9.5–11.5 × 5.5–7 μm	(10.2–) 10.8–15.2 × 5.2–7.2 μm, 12.4 × 6.1 μm
BASIDIOSPORE FORM	Q = 1.5–1.88, ellipsoid to occasionally oblong	ellipsoid	Q = 1.78–2.72, oblong to cylindrical
BASIDIOSPORE PILLARS	subfree	probably free	free
CUTICLE CELLS	clavate, without or with two to three apical or lateral protuberances, occasionally lateral or apical branched	highly variable from nearly spherical or reniform to clavate, often strongly branched or lobed	clavate, generally entire or with one lateral protuberance

*Information for *G. meredithiae* from Adaskaveg & Gilbertson (1988)

The majority of the specimens labeled *G. lucidum* (Curtis) P. Karst. in F were re-determined as *G. curtisii* or *G. ravenelii.* Steyaert (1980) recorded *G. ravenelii* from South Carolina and Florida. The species is now additionally recorded from North Carolina and Texas. Our examination of one immature specimen with features very similar to *G. ravenelii* but possessing few basidiospores leads us to believe that the species probably occurs in Mexico. This Mexican material of *G. ravenelii* differs from the many Mexican specimens of *G. curtisii* we examined (Torres-Torres & Guzmán-Dávalos 2005, specimens in this paper, and other unpublished data).

Acknowledgments

The authors thank Cony Decock and Adriana Guggliota de Mello for their critical reviews and valuable comments on this paper. Thanks are due to the curator of K herbarium for the loan of the type for the study and to Miguel de Santiago for inking the drawings. M.G Torres-Torres especially thanks Gregory Mueller and Betty Strack for their assistance and kind hospitality during her stay in the Botanical section of the Field Museum. The first author also gratefully acknowledges the facilities and financial support received from project NUFFIC-Alterra of Wageningen University, and Universidad Tecnológica del Chocó. Funds also were obtained from CONACYT (project CONACYT-SEP-2003-C02-42957) and Universidad de Guadalajara (project 62935).

Literature cited

Adaskaveg JE, Gilbertson RL. 1988. *Ganoderma meredithiae*, a new species on pines in the southeastern United States. Mycotaxon 31: 251–257.

Bas C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. Persoonia 5: 285–579.

Gilbertson RL, Ryvarden L. 1986. North American Polypores, vol 1. Fungiflora, Oslo, Norway. pp 287–306.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part I: The Herbaria of the world. 8 ed., New York Botanical Garden, Bronx, New York, USA. 693 pp.

Kornerup A, Wanscher JH. 1963. Methuen handbook of colour. Methuen, London.

Moncalvo JM, Ryvarden L. 1997. A nomenclatural study of *Ganodermataceae* Donk. Synopsis Fungorum 11, Fungiflora, Oslo, Norway. 114 pp.

Steyaert RL. 1980. Study of some *Ganoderma* species. Bull Jard Bot Nat Belg 50: 135–186.

Torres-Torres MG, Guzmán-Dávalos L. 2005. Notas sobre la variación morfológica de *Ganoderma curtisii* en México. Rev Mex Mic 21: 39–47.

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Three new species of *Parmotrema* containing salazinic acid from the coast of São Paulo State, southeastern Brazil

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Abstract — During a survey of *Parmeliaceae* species in natural ecosystems and urbanized coastal areas of São Paulo State, southeastern Brazil, three new salazinic acid-containing *Parmotrema* species were discovered namely, *P. anchietanum*, *P. asperum* and *P. hypermaculatum*.

Key words — *Parmotrema cetratum*, *Parmotrema despectum*, *Parmotrema expansum*, *Parmotrema permaculatum*, *Parmotrema ruptum*

Introduction

The genus *Parmotrema* A.Massal. is characterized by broad rotund lobe apices, absence of pseudocyphellae, frequent occurrence of marginal cilia, naked lower margins, simple rhizinae, and thick-walled, ellipsoid ascospores (Brodo et al. 2001, Nash & Elix 2004). More than three hundred species are known worldwide (Nash & Elix 2004), 93 of which occur in Brazil (Marcelli 2004).

This study describes three new species of *Parmotrema* containing salazinic acid. These were discovered by the authors during an investigation of the large lobed species of *Parmeliaceae* on the coast of São Paulo State in Brazil (Benatti 2005), for the most part situated between the municipalities of Ubatuba (23°02'S, 45°04'W) and Itanhaém (24°11'S, 46°47'W). This region included urbanized areas, rocky shores, and mangrove and restinga forests as the predominant vegetation types.

All three species are saxicolous, collected from rocky coastal areas growing fully exposed to sunlight. Two of the new species produce soredia, while the third lacks vegetative propagules.

Although we have included sufficient specific descriptive information about the three new taxa, more detailed morphological and chemical comparisons with other similar species can be found in Benatti (2005).

Materials and methods

Specimens were distinguished by morphological characters using standard stereoscopic and light microscopes. Anatomical sections, including those of apothecia and pycnidia, were made with a razor blade by hand. The chemical constituents were checked by spot tests with potassium hydroxide (K), sodium hypochlorite (C) and para-phenylenediamine (P), and also examined under UV light (360 nm). Chemical constituents were identified by thin-layer chromatography (TLC) using solvent C (Bungartz 2001), high performance liquid chromatography (HPLC) (Elix et al. 2003) and comparison with authentic samples.

Since we have encountered problems dealing with the many morphological terms present in the literature, we specify here that in our concept lacinules represent adventitious, ribbon-like secondary outgrowths from the primary lobe margins. Lobules are similar, but short and rounded.

For each new species diagnosis refers exclusively to holotype characters and the English descriptions and comments to all the material studied.

The species

Parmotrema anchietanum Marcelli, Benatti & Elix, **sp. nov.** **Fig. 1**

MB 511104

Descriptio: *Thallus sublaciniatus, 12.0 cm latus, cinereus, albidus. Lobi angustati, 1.0–3.0 (–5.5) mm lati, parce maculati, apicibus subtruncatis, lacinulis marginalibus abundantibus, magnitudine 0.2–3.2 × 0.2–1.0 mm, margine ciliato, cilia simplicia, frequentia et regulariter distributa, 0.2–1.6 mm longa; soralia capitata, submarginalia, ad pustulas ephemeras oriunda, in soredia subgranulata caducia erumpentia; subtus niger, ambitum versus castaneus, nudus vel rhizinosus, rhizinae simplices vel furcatae, frequenter agglutinata; medulla albida; apothecia ignota; conidiomata frequentia, conidia brevia filiformia, 6.5–11.0 × 1.0 μm; atranorinam, chloroatranorinam, acidum salazinicum et acidum consalazinicum continens.*

Holotype–Brazil, São Paulo State, Municipio Ubatuba, Anchieta Island, Saco Grande, rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. A.A. Spielmann, L.S. Canêz & D.F. Peralta 557b, 23-XI-2003 (SP, isotypes in B and NY).

Thallus up to 16 cm in diameter, coriaceous, saxicolous, light gray darkening in the herbarium, sublaciniate to weakly laciniate; lobes usually irregularly branched, occasionally becoming subdichotomous, 1.0–3.0 (–5.5) mm wide, younger lobes imbricate but soon becoming very crowded, adnate to weakly ascending, loosely attached; UPPER SURFACE continuous then irregularly cracked, smooth to partially rugose, APICES almost flat to subconcave, subtruncate to truncate, MARGINS crenate to irregularly dissected, weakly ascending, subundulate, lacinulate, ciliate; MACULAE weak at the center to distinct in the younger parts, punctiform to linear but never reticulate, laminal, sometimes developing into cracks; LACINULES short, regularly distributed at the lobe margins and apices, abundant, usually simple, more rarely furcate or irregular, flat, 0.2–3.2 × 0.2–1.0 mm, truncate or acute, frequently mixed with small, irregular adventitious lobules, underside concolorous with the lower margin; CILIA black, simple, 0.20–1.60 × ca. 0.05 mm, frequent along the margins. MEDULLA white, pigments absent, but sometimes with reddish parts due the hydrolysis and oxidation of the salazinic acid. SORALIA capitate to irregular, originating from pustules (see below), infrequently coalescing, often exposing the lower cortex when eroded; SOREDIA subgranular to granular, ±coarse. PUSTULES submarginal or subapical on the lobes or subapical at the lacinulae, also frequently appearing on thalline ridges, ephemeral and soon bursting into soredia. ISIDIA absent. LOWER SURFACE black, shiny, smooth to subpapillate; MARGIN brown, shiny, smooth to subpapillate, 1.0–3.0 mm wide, usually naked to partially rhizinate; RHIZINES black even at the margin, simple, furcate or rarely irregular, 0.20–1.40 (–3.60) × 0.05–0.10 mm, frequent to dense in some parts, frequently becoming agglutinated, scattered. APOTHECIA absent. PYCNIDIA submarginal and common, sometimes on the lacinulae, with black ostioles; CONIDIA short filiform, 6.5–11.0 × ca. 1.0 μm.

SPOT TESTS: upper cortex K+ yellow, UV–; medulla K+ yellow→red, C–, KC similar to K but weaker due to the C, P+ yellow, UV–.

TLC/HPLC: cortical atranorin (minor), chloroatranorin (minor); medullary salazinic acid (major), consalazinic acid (minor).

PARATYPES — Brazil, São Paulo State, Municipality of Ubatuba, Anchieta Island, Saco Grande rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. A.A. Spielmann, L.S. Canêz & D.F. Peralta 557a, 23-XI-2003 (S); idem, over granite on the rocky shore in the shade, 23°02'S, 45°04'W, 2 m alt., leg. L.S. Canêz & A.A. Spielmann 607b, 23-XI-2003 (SP); idem, over granite on the rocky shore, 23°02'S, 45°04'W, 2 m alt., leg. L.S. Canêz & A.A. Spielmann 620, 23-XI-2003 (SP).

COMMENTS– This species is characterized by the sublaciniate lobes with lacinulate margins, somewhat resembling large specimens of *Parmelinopsis* or *Bulbothrix*, or even small specimens of *Parmotrema reticulatum* (Taylor) M. Choisy.

Parmotrema anchietanum is further characterized by the pale gray upper cortex, the ciliate margins and formation of pustular soralia, especially at the subapical parts of the lobes and lacinules. Although maculae are apparent in parts of the upper cortex, especially in the young, peripheral lobes, they are much less prominent than those observed in species formerly accommodated in *Canomaculina* or *Rimelia*. Indeed, the maculae are barely visible in the central parts of the thallus because of the very pale gray colour of the cortex.

Unlike other sorediate *Parmotrema* species, which commonly have a cream or white coloured margin below the soralia, this species has an entirely brown lower margin.

The lower surface of *P. anchietanum* is only partially nude at the margins due to an irregular pattern of rhizine distribution, some lobes having completely nude lower margins, while others are rhizinate close to the edges, or even entirely rhizinate. The majority of rhizines are simple, but they are mixed with a few furcate or irregularly branched ones, and are frequently agglutinated at the initial stages. The species formely attributed to *Canomaculina* and *Rimelia* have dimorphic or squarrosely branched rhizines, respectively, but these were not observed in *P. anchietanum*. This species has a very smooth and shiny lower cortex, with a few papillate parts and is sometimes randomly cracked.

The development of small, marginal lacinules is quite common in *P. anchietanum*. The soralia are most common in the subapical region of the lacinules, more rarely occurring submarginally or on thalline ridges. They originate from foam-like, ephemeral pustules, which soon burst and form caducous soredia, frequently exposing the upper part of the lower cortex. Sometimes these soredia have a weakly yellowish tinge, possibly due to hydrolysis and oxidation of salazinic acid, since no pigment was found in the medulla.

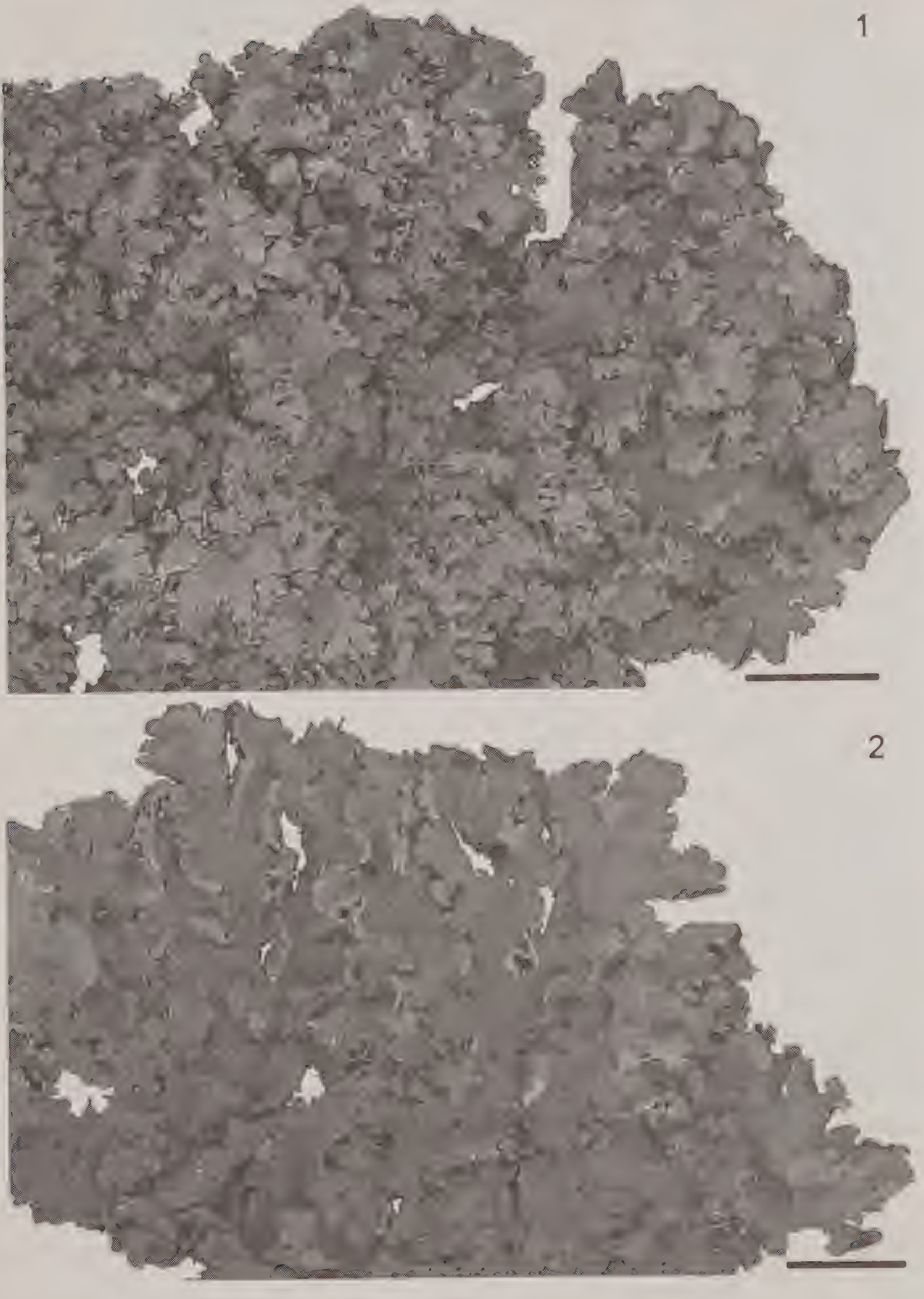
Some specimens exhibited traces of unidentified fatty acids (or other substances) in TLC, substances that were also observed in some specimens of *P. asperum* collected at the same locality (see below).

This species is named after Anchieta Island, the only known collection locality on the northern coast of São Paulo State, Brazil.

Parmotrema asperum Benatti, Marcelli & Elix, **sp. nov.** **Fig. 2**

MB 511105

Descriptio: *Thallus sublobatus, fragmentatus, 11.0 cm latus, lactineocinereus. Lobi angusti, (1.0–) 2.0–6.5 mm lati, dense maculati, apicibus subrotundatis vel subtruncatis, lacinulis marginalibus satis irregulariter formantes, 0.2–2.2 × 0.2–0.9 mm, margine ciliatis, cilia simplicia et irregulariter distributa, 0.2–0.8 (–1.3) mm longa; soralia capitata, subapicalia, ad pustulas ephemeras oriunda, in soredia granulata et agglutinata incompleta erumpentia; subtus niger, ambito castaneus nudus vel pro parte modice rhizinatus, rhizinae simplices vel furcatae, aliquando agglutinatae; medulla albida; apothecia ignota; conidiomata frequentia, conidia brevia filiformes, 6.5–11.0 × 1.0 µm; atranorinam, chloroatranorinam, acidum salazinicum, acidum consalazinicum et acidum divaricaticum continens.*



Figures 1-2. **1.** *Parmotrema anchietanum* (part of the holotype).
2. *Parmotrema asperum* (part of the holotype).
Bars = 10 mm.

Holotype–Brazil, São Paulo State, Municipio de Ubatuba, Ilha Anchieta, Saco Grande rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. *A.A. Spielmann*, L.S. Canêz & D.F. Peralta 587a, 23-XI-2003 (SP, isotypes in US and S).

Thallus fragile, up to 11 cm in diameter, coriaceous, saxicolous, milky gray becoming darker in the herbarium, lobate; lobes (1.0–) 2.0–6.5 mm wide, irregularly branched, younger lobes overlapping laterally, then becoming crowded, adnate to weakly ascending, loosely attached; upper surface continuous, then irregularly cracked, smooth to ±rugose, apices ±flat to subconcave, subrotund to subtruncate or irregular, margin crenate to irregularly dissected, ±ascending, subundulate, sublacinulate, irregularly ciliate; maculae distinct, linear to somewhat reticulate, denser at the center, laminal, sometimes forming cracks; lacinules short and irregularly spreading at the apices and lobe margins, frequently intermixed with small irregular lobules, simple or irregular, flat, 0.2–2.2 × 0.2–0.9 mm, truncate or acute, underside concolorous with the lower margin; cilia black, simple, 0.2–0.8 (–1.3) × ca. 0.05 mm, absent on some young lobes, but frequent to irregular on mature lobes. Medulla white, pigments absent, but ±reddish spotted due to hydrolysis and oxidation of salazinic acid. Soralia capitate to irregular, originating from pustules (see below), ±coalescing, frequently agglutinated due to incomplete eruption of the pustules, soredia granular, coarse, agglutinated. Pustules subapical on the lobes or lacinules, sometimes also developing on thalline ridges, ephemeral and soon breaking down into soredia, but often incompletely so. Isidia absent. Lower surface black, shiny, smooth to rugose and papillate, margin shiny, brown, smooth to subpapillate, 1.0–3.0 mm wide, naked to partially rhizinate; rhizines black even when growing at the margin, simple, furcate or ±irregular, 0.20–1.70 (–2.80) × 0.05–0.10 mm, scattered but frequent to dense in some parts, ±becoming agglutinated. Apothecia absent. Pycnidia common, submarginal and on the lacinules, with black ostioles; conidia short filiform, 6.5–11.0 × ca. 1.0 μm.

Spot tests: upper cortex K+ yellow, UV–; medulla K+ yellow→red, C–, KC similar to K but paler, P+ yellow, UV–.

TLC/HPLC: cortical atranorin (minor) and chloroatranorin (minor); medullary salazinic acid (major), consalazinic acid (minor), and divaricatic acid (trace).

Paratypes — Brazil, São Paulo State, Municipality of Ubatuba, Anchieta Island, Saco Grande rocky shore, 23°02'S, 45°04'W, 2 m alt., saxicolous, leg. A.A. Spielmann, L.S. Canêz & D.F. Peralta 561 (B), 609 (SP), 613, 23-XI-2003; idem, 23°02'S, 45°04'W, 2 m alt., over granite in a shaded place on the rocky shore, leg. L.S. Canêz & A.A. Spielmann 607, 23-XI-2003 (SP).

Comments– The habit and maculation of *Parmotrema asperum* resembles that of *P. reticulatum*, and it has narrower and less rounded lobes than species of the *P. cristiferum* (Taylor) Hale group. This species has a characteristic milky gray colour due to the strongly maculate upper cortex, and the margins are frequently irregularly lacinulate and ciliate.

Both *P. anchietanum* and *P. asperum* differ from the other salazinic acid containing *Parmotrema* species by producing pustular, subapical soralia on the lobes, lacinules, and thalline ridges. Like *P. anchietanum*, the margins of the lower surface of *P. asperum* are brown and in part naked, in part rhizinate with mainly simple rhizines. The surface below the soralia is also brown.

In contrast to *P. asperum*, *P. anchietanum* has a darker gray upper cortex, an alternative disposition and ontogeny of the pustular soralia, and more uniformly ciliate margins. The two species also differ in the nature of the lobes and lacinules. Thus the thallus of *P. asperum* has broader, subrotund lobes with typically short, irregular, unevenly distributed, adventitious marginal lacinules and lobules which are more common on older lobes whereas *P. anchietanum* has narrower, sublaciniate lobes with more regularly distributed marginal lacinules which are distinctly linear. Furthermore, *P. anchietanum* has poorly developed, punctiform maculae which are, for the most part, restricted to the very young lobes, whereas in *P. asperum* and *P. hypermaculatum* (see below), the maculae are often large and dense all over the upper surface where the irregularly dispersed algal cells give rise to small greenish spots scattered over the upper cortex.

The soralia of *P. asperum* are subapical and apical on the lobes and lacinules, but are less common on the thalline ridges. Coarse or granular 78–223 (–305) µm soredia originate from pustules, which only partially burst open, such that the soredia remain agglutinated instead of being shed. The soredia in *P. anchietanum* are finer (52–137 µm) due to the more complete breakdown of the pustules. As a consequence the soredia are often completely shed thus exposing the black upper side of the lower cortex. Also, the soralia of *P. anchietanum* only rarely reach the extremities of the lobes and lacinules, leaving a small but constant esorediate area at the apices.

The specimens of *P. asperum* contained traces of divaricatic acid, which may have originated from sorediate *Dirinaria* species growing nearby. The soredia from such species are often washed on to adjacent lichens. Although some specimens of *P. anchietanum* showed a similar faint spot in TLC, no substances other than the salazinic and consalazinic acids were detected by HPLC.

This species is named after the very granular, agglutinated soredia, which derive from rough soralia following the incomplete breakdown of the pustules, giving the thallus a characteristic, coarse appearance.

Parmotrema hypermaculatum Marcelli, Benatti & Elix, **sp. nov.** **Fig. 3**

MB 511106

Diagnosis: *Species thallo similis Parmotremati expanso, sed subcoriaceus non fragilis, ciliis plerumque simplicibus, superne cortex dense maculatus, medulla acidum protocetraricum continens, sporis ellipsoideis minoribus (10.0–14.0 × 6.5–9.0 µm) episporio 1.0 µm et conidiis filiformibus majoribus plerumque 9.0–14.0 × 1.0 µm differt.*

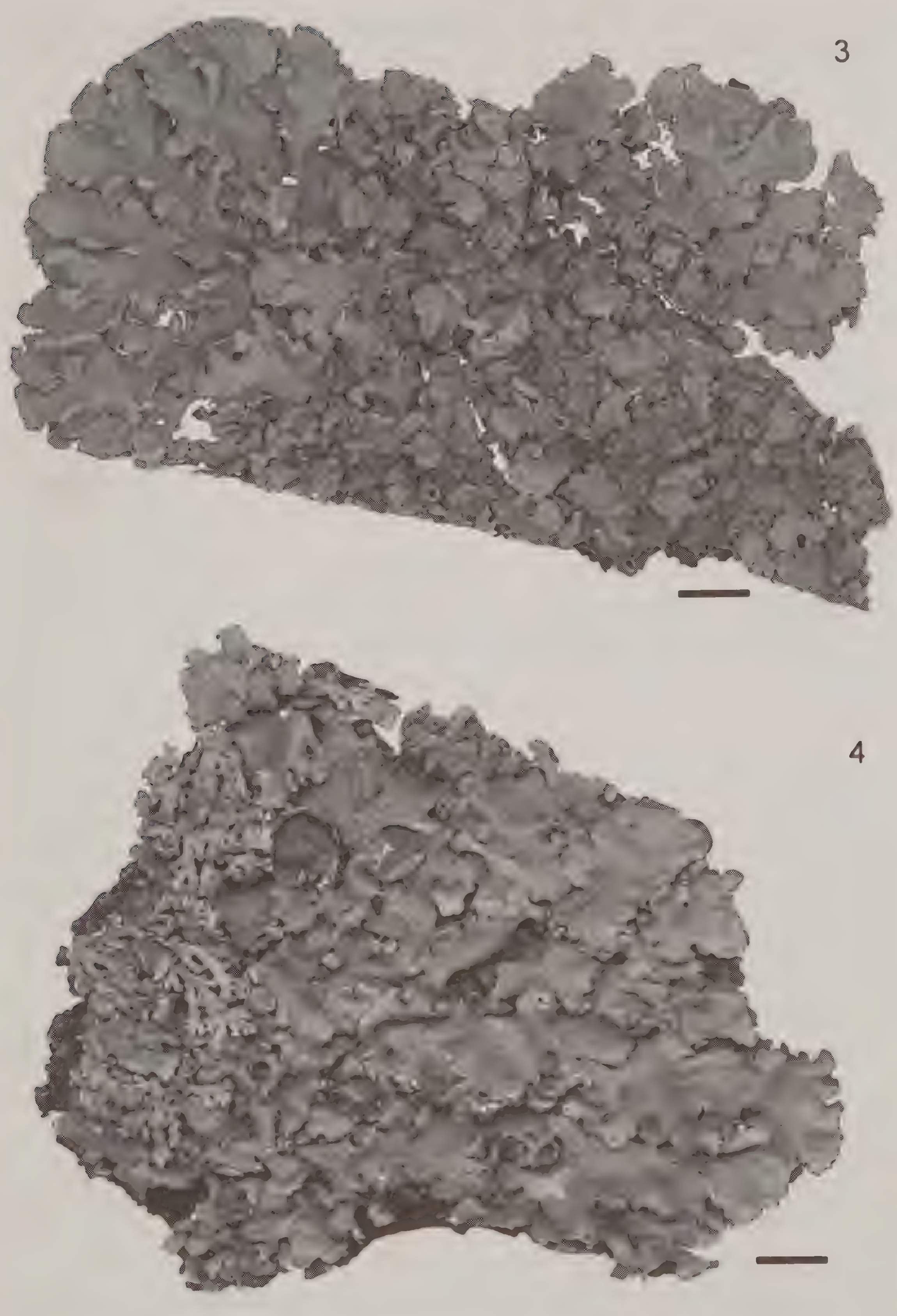
Holotype–Brazil, São Paulo State, Municipio Itanhaém, Cibratel quarter, rocky shore between Praia dos Sonhos and Praia de Itanhaém, 24°11'S, 46°47'W, 25 m alt., on the leeward side of a small grass-covered granitic rock, leg. M.P. Marcelli 4198, 10-I-1989 (SP, isotypes in CANB and G).

Thallus up to 19 cm in diameter, subcoriaceous, saxicolous, grayish becoming darker gray on storage, lobate; lobes (2.0–)4.0–11.0 mm wide, irregularly branched, overlapping laterally and crowded at the thallus center, adnate to weakly ascending, loosely attached; upper surface smooth to scrobiculate, continuous, becoming irregularly cracked to almost rimose-reticulate in some parts, apices slightly revolute, subrounded to irregular, margin smooth to highly incised and crenate, weakly ascending or mostly ±flat, irregularly dissected and sublacinulate in older parts, ciliate; maculae laminal and amphithecial, usually distinct, but faint in young apothecia, linear to reticulate, very dense, often developing into cracks; lacinules short and irregular in size and shape, unevenly dispersed at the apices and along the margins of older lobes, admixed with some small, irregular adventitious lobules, simple or irregularly branched, flat, 0.5–2.3 × 0.4–1.7 mm, apices truncate or rarely acute, underside concolorous with the lower margin; cilia black, usually simple, rarely furcate or irregularly branched, 0.2–2.6 × 0.05–0.15 mm, sparse to frequent along the margins; medulla white, pigments absent, but sometimes reddish spotted due to hydrolysis and oxidation of salazinic acid. Soralia, pustules and isidia absent. Lower surface black, shiny, smooth to subrugose, subvenate or subpapillate; margin shiny, brown, smooth, rugose to papillate, 1.0–5.0 mm wide, naked, cream coloured or variegated under fertile lobes; rhizines black, simple, furcate or irregularly branched, 0.2–2.2 (–3.4) × 0.05–0.15 mm, frequent to dense, scattered. Apothecia submarginal and common, concave to urceolate, becoming ±flat and sometimes distorted when old, 0.5–7.6 mm wide, substipitate, margins smooth, eciliate; amphithecium and stipe smooth, turning rugose when older; disc brown, epruinose, imperforate, ±incised when old; ascospores ellipsoid, 10.0–14.0 × 6.5–9.0 μm, epispore ca. 1.0 μm wide; pycnidia submarginal and common, abundant on lobules or lacinules, with black ostioles; conidia filiform (7.0–) 9.0–14.0 × ca. 1.0 μm.

Spot tests: upper cortex K+ yellow, UV–; medulla K+ yellow→red, C–, KC similar to K but paler, P+ yellow, UV–.

TLC/HPLC: cortical atranorin (minor) and chloroatranorin (minor); medullary salazinic acid (major), consalazinic acid (minor), and protocetraric acid (trace).

Paratype — Brazil, São Paulo State, Municipality of Itanhaém, Cibratel quarter, rocky shore between Praia dos Sonhos and Praia de Itanhaém, 24°11'S, 46°47'W, 10 m alt., on steep granitic rock near the sea, leg. M.P. Marcelli, M.M. Marcelli & M.M. Marcelli 6224, 03-IV-1989 (SP).



Figures 3-4. 3. *Parmotrema hypermaculatum* (part of the holotype).
4. *Parmotrema ruptum* (holotype).
Bars = 10 mm.

Table 1. A comparison of *P. hypermaculatum* with the lectotype of *P. ruptum* and the holotype of *P. expansum.*

	P. EXPANSUM	P. RUPTUM	P. HYPERMACULATUM
Lobe width (mm)	6–10	4–6	4–11
Maculae	effigurate (!, S)	reticulate	markedly reticulate
Cilia (mm)	often furcate 0.5–1.2	simple 0.2–0.5 (!)	usually simple 0.2–2.6
Apothecium	imperforate (S)	imperforate	imperforate
Ascospore size (µm)	17.5–21×10–14 (!)	10–12.5×6.0–7.5 (S)	10–14×6.5–9
Conidia size (µm)	6–9 × 0.5	10–12.5 × 1 (S)	9–14 × 1
Medullary acids	salazinic*	salazinic*	salazinic (major), consalazinic (minor), protocetraric (trace)

(*) Data from literature. (!) Differs significantly from original description. (S) A.A. Spielmann personal communication.

COMMENTS – *Parmotrema hypermaculatum* is a saxicolous species that lacks vegetative propagules and has a very densely reticulate-maculate upper cortex that sometimes becomes irregularly cracked without becoming reticulate-rimose. The maculae often become so enlarged that they restrict the grayish-green colored areas with algae to small, scattered spots. The margins are moderately ciliate. The apothecia are imperforate, shortly stipitate, and have an eciliate thalline exciple, which is smooth when young but becomes rugose and incised with age.

According to Hale (1977), *Parmotrema expansum* Hale, a very similar species, is distinguished by its subimbricate lobes, frequently furcate cilia and an upper cortex that becomes somewhat rimose-reticulate in the central parts due to the agglomeration of age-dependent cracks, thus more closely resembling those species formerly placed in *Rimelia.* In addition the ascospores of *P. expansum* are considerably larger than those of *P. hypermaculatum* (17.5–21.0 × 10.0–14.0 µm vs. 10.0–14.0 × 6.5–9.0 µm) and the conidia somewhat shorter (6.0–9.0 × 1.0 µm vs. 7.0–14.0 × 1.0 µm).

Lynge´s description of *Parmelia rupta* [*Parmotrema ruptum* (Lynge) Hale] (Lynge 1914) cites only one corticolous specimen (lectotype in S!, Fig. 4), which differs from *P. hypermaculatum* by having much narrower lobes (4–6 mm vs. 4-11 mm wide), shorter (0.5–1.0 mm vs. 0.2–2.6 mm long), simple cilia and small subglobose spores (9.0–11.0 × 5.5–8.0 µm vs. 10.0-14.0 x 6.5-9.0 µm). Hale (1960) commented that Lynge's specimen was very similar to *Parmotrema cetratum* (Ach.) Hale, apart from the nude lower margins. We confirmed this to be the case with the type resembling a small, weakly reticulate, weakly cracked, elacinulate specimen of *P. cetratum* with nude lower margins. No medullary substance other than salazinic acid is reported for *P. ruptum*.

The original descriptions of *P. ruptum* and *P. expansum* recorded significant differences in lobe width, cilia ramification and ascospore size (Lynge 1914, Hale 1977). Following a comparison of the lectotype of *P. ruptum* with the holotype of *P. expansum*, we consider that these differences are indeed, significant. Thus, the cortex of *P. ruptum* is maculate in a reticulate pattern, whereas *P. expansum* has typical, effigurate maculae (A.A. Spielmann, pers. comm.) which do not resemble *Rimelia*. Consequently, we do not accept these names as synonyms as recommended by Hale & DePriest (1999), but consider them to be similar, possibly related species from this very complicated, salazinic acid containing group (Table 1).

Parmotrema permaculatum (Hale) Kurok. is a further species that resembles *P. hypermaculatum*, but it is corticolous, has a more coriaceous thallus, and sessile, perforate apothecia. Moreover, the lobes of *P. permaculatum* are broader (8-15 mm vs. 4-11 mm wide), the ascospores somewhat larger (13.0–16.0 × 8.0–10.0 µm vs. 10–14 × 6.5–9 µm), and lacinules and lobules are absent (Hale 1971, Kurokawa 2001).

According to Kurokawa (2001), *P. despectum* Kurok. has a very coriaceous thallus with a weakly maculate upper cortex, sparse to rare cilia, ±perforate apothecia with a ± rugose amphithecium. Despite some morphological and ascospore similarities with *P. hypermaculatum*, *P. despectum* has a more regular pattern of lobule formation along the margins, with more rounded lobules, while *P. hypermaculatum* has irregular, truncate lobules or lacinules which are scattered and spread irregularly along the margins.

Although Benatti (2005) mentioned caperatic acid detected in TLC, this substance was not confirmed in HPLC analysis.

This species name (*hypermaculatum*) refers to the strong, often dense, reticulate pattern of maculae developed over the entire upper cortex.

Additional comments on other related species containing salazinic acid such as *Parmotrema eurysacum* (Hue) Hale and *P. mantiqueirense* Hale can be found in Benatti (2005).

A more detailed overview of the many problems regarding the salazinic acid-containing group of *Parmotrema* species without vegetative propagules can be found in Spielmann (2005).

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The authors wish to thank Harrie J. M. Sipman and Robert Egan for the critical revision of the manuscript, Teuvo Ahti (Helsinki) for the revision of the Latin descriptions, Anders Tehler (S) for the loan of the type specimen of *Parmotrema ruptum*, George Russell (US) for loan of the type specimen of *Parmotrema expansum*, and Adriano Afonso Spielmann (Brazil) for original data from his PhD thesis [in preparation].

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Literature cited

Benatti MN. 2005. Os gêneros *Canomaculina*, *Parmotrema* e *Rimelia* (*Parmeliaceae*, Ascomycetes) no litoral centro-sul do Estado de São Paulo. Mastership Dissertation, Instituto de Botânica, São Paulo, 389 pp.

Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. Yale University Press. New Haven. 795 pp.

Bungartz F. 2001. Analysis of lichen substances. In http://ces.asu.edu/ASULichens/plb400/laboratory/chemistry/tlc.html. Accessed in October 2004.

Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. Bibliotheca Lichenologica 86: 1-7.

Hale BW, DePriest PT. 1999. Mason E. Hale's list of epithets in the parmelioid genera. The Bryologist 102(3): 462-544.

Hale ME. 1960. A revision of the South American species of *Parmelia* determined by Lynge. Contributions from the United States National Herbarium 36(1): 1-41.

Hale ME. 1971. *Parmelia permaculata*, a new lichen from Alabama and Mexico. Phytologia 21(6): 425.

Hale ME. 1977. New species in the lichen genus *Parmotrema* Massalongo. Mycotaxon 5(2): 432-448.

Kurokawa S. 2001. Taxonomic notes on *Parmelia reparata* (*Parmeliaceae*, Lichenes) and the related species. Bulletin of the Natural Science Museum of Tokyo, ser. B, 27(1): 1-10.

Lynge B. 1914. Die Flechten der ersten Regnellschen Expedition. Die Gattungen *Pseudoparmelia* gen. nov. und *Parmelia* Ach. Arkiv för Botanik 13(13): 1-172.

Marcelli MP. 2004. Checklist of lichens and lichenicolous fungi of Brazil. Version 1: June 2004. http://www.biologie.uni-hamburg.de/checklists/brazil_l.htm.

Nash TH III, Elix JA. 2004. *Parmotrema*. In Nash III, TH, Ryan, BD, Diederich P, Gries C, Bungartz F (Eds). Lichen flora of the greater Sonoran Desert Region. Volume 2. Lichens Unlimited, Arizona State University, Tempe, Arizona, USA. pp. 318-329.

Spielmann AA. 2005. A família *Parmeliaceae* (fungos liquenizados) nos barrancos e peraus da encosta da Serra Geral, Vale do Rio Pardo, Rio Grande do Sul, Brasil. Masters Dissertation, Instituto de Botânica, São Paulo, 204 pp.

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Dacampia cladoniicola sp. nov. (*Ascomycota, Dacampiaceae*) on *Cladonia* sp. from Turkey

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Abstract — *Dacampia cladoniicola* is described as new from four collections of squamules of an unidentified *Cladonia* sp. in western Turkey. It differs from the other members of the genus in the shorter and relatively narrow ascospores. The new species is the first *Daçampia* species reported on *Cladonia*.

Key words — lichenicolous fungi, lichens, France

Introduction

In the course of determining lichenicolous fungi from Turkey, one new genus (Hawksworth & Halıcı 2007) and eight new species have been described as new to science (Halıcı et al. 2005, 2007a, b; Halıcı & Hawksworth 2007a, b). Also, many taxa were reported as new records for the country (Halıcı et al. 2006, 2007a, b, c). Here we describe a new species of *Dacampia* growing on *Cladonia*.

The genus *Dacampia* (*Ascomycota, Dothideales, Dacampiaceae*) currently comprises seven species (Halıcı & Hawksworth 2007b). Recently Halıcı & Hawksworth (2007b) provided a key and synopsis to the species, along with drawings of the ascospores. In that study, it was found that *Dacampia* species are generally restricted in their host range, and mostly occur on foliose genera, including *Peltigera*, *Solorina*, and *Leptogium*. However, the type species of the genus; *D. hookeri*, is an independent lichen (Henssen 1995).

Material and methods

The type material of the new species is deposited in ANES. Specimens were examined with an Olympus BH-2 research microscope fitted with Nomarski differential interference contrast optics and a drawing tube. Photomicrographs were prepared on a Nikon Eclipse 80i. Sections were prepared by hand and examined in I (Lugol's iodine and Metzler's iodine, with [K/I] and without [I] pre-treatment with 10% KOH), 10% KOH alone, and water. Ascospore measurements were made in water and 10% KOH; the extreme values outside the main range are given in parentheses. The length/breadth (l/b) ratio of the ascospores is given in the same way.

The species

Dacampia cladoniicola Halici & A.O.Türk, **sp. nov.** FIGURES 1-2

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Dacampia species insignis ascosporis 3-transseptatiis et 1(-2)-longiseptatis, (9.5–)10.5–12(–12.5) × (4.5–)5.5– 6.5 µm (n = 20), l/b = (1.6–)1.9–2.2(–2.6).

Typus: Turkey, Manisa, Salihli, Western part of Demirköprü Dam, 38°39'N, 28°20'E, alt. 285 m, on squamules of *Cladonia* sp. on mosses, 15 August 2006, leg. M. Candan (ANES 11038 – holotypus).

Etymology: The epithet "*cladoniicola*" refers to the host *Cladonia*.

Description: Lichenicolous, on the squamules of *Cladonia* sp., causing bleaching and apparently suppressing podetia production in infected squamules, pathogenic. Ascomata perithecioid, arising singly, immersed at first with only the ostiole and surrounding zone externally visible, semi-immersed (⅔ to ½) at maturity, 150–200 µm diam, 1–2 per areole, black, subglobose. Ostiole not papilliform, ~ 30 µm diam. Exciple composed of 6–8 layers of angular pseudoparenchymatous cells, textura angularis, 25–50 µm thick, the individual cells somewhat radially compressed, reddish brown to brown, individual cells 8–12 × 6–8 µm in vertical section, smooth, walls ca 1 µm thick. Hamathecium of cellular pseudoparaphyses, abundant, septate, branched and anastomosed, 1.5–2 µm wide; centrum Lugol's and Metzler's solution (after pre-treatment with 10% KOH) I–. Asci elongate-clavate, very shortly stalked, bitunicate in structure, 8-spored in mature asci, (28–)32 × 10–14 µm. Ascospores irregularly biseriately arranged and overlapping in the asci, ellipsoid, pale brown, rounded to somewhat broadly pointed at the apices, muriform, with 3 transsepta and 1(–2) longisepta, smooth-walled, slightly constricted at the septa, cells similarly coloured, lacking a conspicuous gelatinous sheath, (9.5–)10.5–12(–12.5) × (4.5–)5.5–6.5 µm (*n* = 20), l/b = (1.6–)1.9–2.2(–2.6). Conidiomata not observed.

Ecology and distribution: The species appears to be pathogenic as bleaching is seen in the infected squamules of the host, and podetia production is suppressed. The new species is known from four collections, all from western Turkey. Also, Paul Diederich (pers. comm.) informed us about a further specimen of the new species: France, Alpes-de Haute-Provence, au nord de

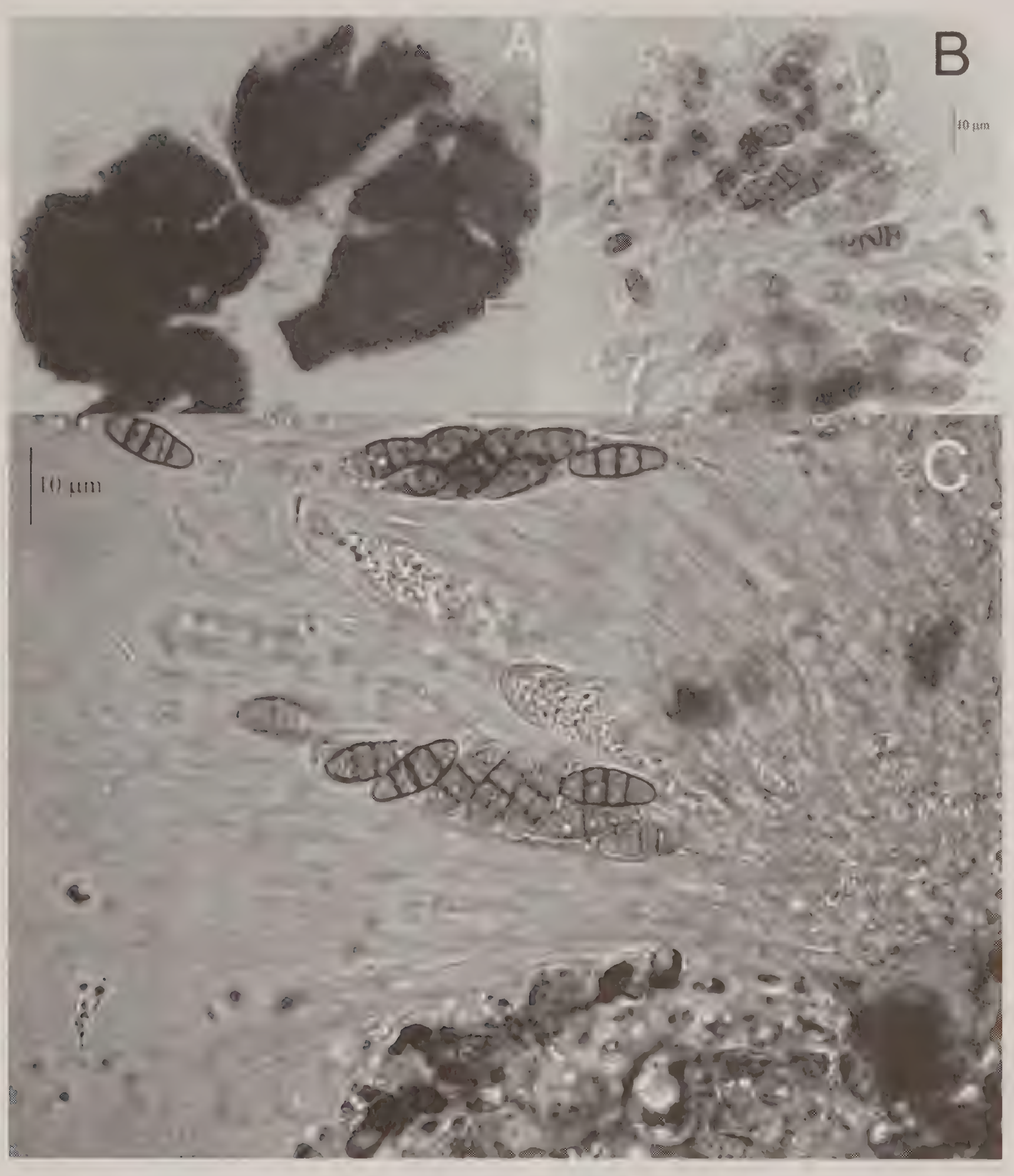

Fig. 1. ***Dacampia cladoniicola*** (holotype). A, Surface view of ascomatal wall showing the angular pseudoparenchymatous cells in K. B, Ascospores in K, C, Asci and arrangement of ascospores in asci and pseudoparaphyses in K. Scales A = 100 µm, B = 10 µm, C = 10 µm.

St-Etienne-les-argues, vers Notre Dame de Lure, on terricolous *Cladonia*, 27 May 2006, P. Diederich 12964 (herb. Diederich). Like in the Turkish specimens, the host has only squamules and no podetia. The infected squamules are not bleached (as in the Turkish specimens), but much darker, almost black. As the host genus has a wide distribution in the world, the species should be searched for elsewhere.

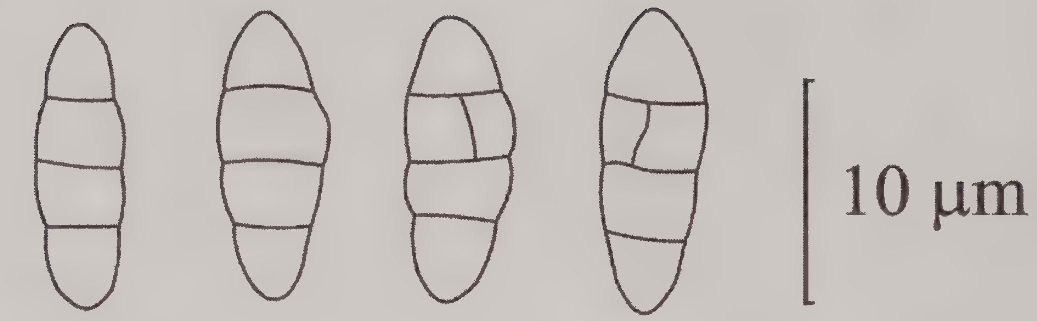

Fig. 2. ***Dacampia cladoniicola*** (holotype). 8 ascospores outline. Scale = 10 µm.

OBSERVATIONS: *Dacampia cladoniicola* is separated from the other members of the genus in having much shorter and relatively narrow ascospores. Also, there is no previous report of any *Dacampia* species on *Cladonia* spp. The narrowest ascospores in the genus are seen in *Dacampia leptogiicola* where they measure 21–25 × 5–6.5 µm, but that species has much longer and also 7-transseptate ascospores and grows on cyanolichens in the genera *Pannaria* and *Leptogium* (Halıcı & Hawksworth 2007b). The other species of the genus with 3-transseptate ascospores, *D. rufescentis* [ascospores (23–)24.5–27 × 11–13 µm] and *D. engeliana* [18–25 × 8–10 µm] have much longer and wider ascospores as well, and grow on different hosts (Halıcı & Hawksworth 2007b).

ADDITIONAL SPECIMENS EXAMINED: Turkey, Manisa, Kula, Southernwest part of Kenger Village, 38°36'N, 28°28'E, alt. 830 m, on squamules of *Cladonia* sp. on mosses, 16 August 2006, leg. M. Candan (ANES 11039); Manisa, Köprübaşı, Western part of Demirköprü Dam, 38°39'N, 28°20'E, alt. 285 m, on squamules of *Cladonia* sp. on mosses, 16 August 2006, leg. M. Candan, (ANES 11042); Eskişehir, Bozdağ, Türkmen Hill, 39°54'N, 30°41'E, alt. 1500 m, on squamules of *Cladonia* sp. on soil, 21 November 2006, leg. M. Candan & T. Tay (ANES 11045).

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Literature cited

Halıcı MG, Orange A, Aksoy A. 2005. *Weddellomyces turcicus*, a new species on a grey *Acarospora* from Turkey. Mycotaxon 94: 249-252.

Halıcı MG, Kocakaya M, Aksoy A. 2006. Additional and interesting lichenized and lichenicolous fungi from Turkey. Mycotaxon 96: 13-19.

Halıcı MG, Kocourková J, Diederich P, Aksoy A. 2007a. *Endococcus variabilis*, a new species on *Staurothele areolata*. Mycotaxon 100: 337-342.

Halıcı MG, Atienza V, Hawksworth DL. 2007b. Two new *Polycoccum* species from Turkey. Mycotaxon 101: 157-163.

Halıcı MG, Özdemir Türk A, Candan M. 2007a. New records of pyrenocarpous lichenicolous fungi from Turkey. Mycotaxon 99: 201-206.

Halıcı MG, Candan M, Özdemir Türk A. 2007b. New records of lichenicolous and lichenized fungi from Turkey. Mycotaxon 100: 255-260.

Halıcı MG, Hawksworth DL, Aksoy A. 2007c. New and interesting lichenicolous fungi records from Turkey. Nova Hedwigia 85: in press.

Halıcı MG, Hawksworth DL. 2007a. Two new species of lichenicolous fungi from Turkey. Lichenologist 39: in press.

Halıcı MG, Hawksworth DL. 2007b. Two new species of *Dacampia*, with a key to and synopsis of the known species of the genus. Fungal Diversity 27: in press.

Hawksworth DL, Halıcı, MG. 2007. *Gemmaspora*, a new verrucarialean genus with remarkable ascospores for *Adelococcus lecanorae* growing on *Aspicilia* species in Syria and Turkey. Lichenologist 39: 121-128.

Henssen A. 1995. Studies on the biology and structure of *Dacampia* (*Dothideales*), a genus with lichenized and lichenicolous species. Crypt. Bot. 5: 149-158.

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Rare and noteworthy lepiotaceous species (*Basidiomycota, Agaricales, Agaricaceae*) from Israel

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Abstract—Four species of lepiotaceous fungi are reported as new to Israel: *Leucoagaricus pilatianus, Lepiota apatelia, L. subgracilis* and *Macrolepiota konradii*. The second is new for Asia.

Key words—*Leucocoprineae, Lepioteae,* Near East

Introduction

Although the family *Agaricaceae* has been the focus of interest for many studies (e.g. Kühner 1936, Babos 1979, Wasser 1980, Bon 1981, Candusso & Lanzoni 1990, Guzmán & Guzmán-Dávalos 1992, Vellinga 2001), it has not been included in inventories of Israeli mycobiota. However, three out of the four agaricaceous tribes as delimited by Singer (1986) and Wasser (1980) are represented in Israel: *Agariceae* Pat., *Leucocoprineae* Singer, and *Lepioteae* Fayod. Wasser (1995, 1996, 1997, 1998, 2000, 2002) has published his reevaluations of earlier data regarding Israeli taxa in the tribe *Agariceae* and reported on 43 taxa representing four genera in *Agariceae* (Wasser 2002). Other tribes, which have not been well studied, require further study. Fragmentary data on some *Leucocoprineae* and *Lepioteae* species is available in more general publications on the higher basidiomycetes of Israel (Avizohar-Hershenzon 1967, Binyamini 1973, 1974, 1975, 1976a,b,c, 1984, 1989; Didukh et al. 2002, 2004; Reichert & Avizohar-Hershenzon 1953, 1955, 1959). Our literature review identified the following 28 lepiotaceous species: *Chlorophyllum molybdites* (G. Mey.) Massee, *Macrolepiota excoriata* (Schaeff.) M.M. Moser, *M. fuligineosquarrosa* Malençon,

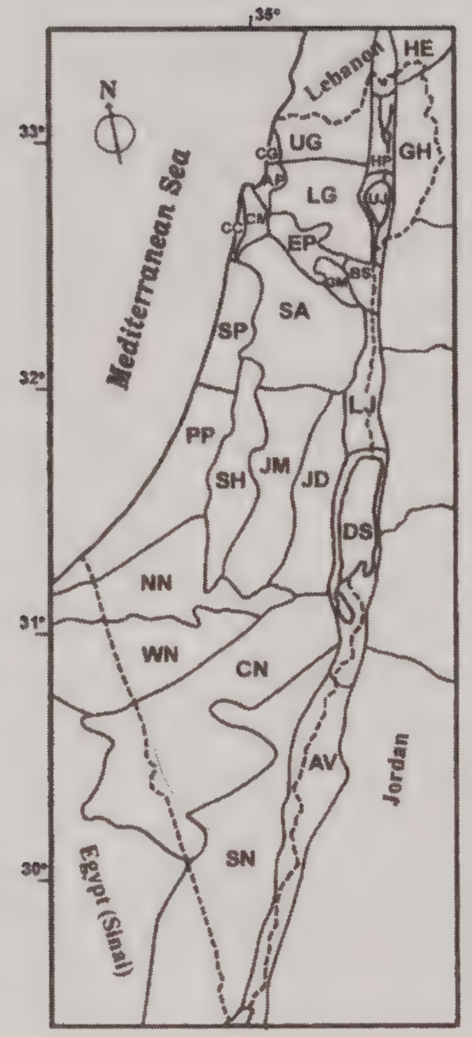

Figure 1: Nature regions of Israel: **AP** – Akko Plain; **AV** – Arava Valley; **BS** – Beit Shean Valley; **CC** – Carmel Coast; **CG** – Coast Galilee; **CM** – Carmel Mount; **CN** – Central Negev; **DS** – Dead Sea Area; **EP** – Esdraelon (Yizre'el) Plain; **GH** – Golan Heights; **GM** – Gilboa Mount; **HE** – Hermon Mount; **HP** – Hula Plain; **JD** – Judean Desert; **JM** – Judean Mts.; **LG** – Lower Galilee; **LJ** – Lower Jordan Valley; **NN** – Northern Negev; **PP** – Philistean Plain; **SA** – Samaria; **SH** – Shefela; **SN** – South Negev; **SP** – Sharon Plain; **UG** – Upper Galilee; **UJ** – Upper Jordan Valley; **WN** – Western Negev.

M. mastoidea (Fr.) Singer, *M. procera* (Scop.) Singer, *M. prominens* (Fr.) M.M. Moser, *M. rachodes* (Vittad.) Singer, *Leucoagaricus carneifolius* (Gillet) Wasser, *La. leucothites* (Vittad.) Wasser, *La. littoralis* (Menier) M. Bon & Boiffard, *La. wichanskyi* (Pilát) M. Bon & Boiffard, *Chamaemyces carmelensis* M. Didukh & Wasser, *Ch. fracidus* (Fr.) Donk, *Leucocoprinus birnbaumii* (Corda) Singer, *Lc. cretatus* Locq. ex Lanzoni, *Lepiota alba* (Bres.) Sacc., *L. brunneoincarnata* Chodat & C. Martin, *L. brunneolilacea* M. Bon & Boiffard, *L. castanea* Quél., *L. clypeolaria* (Bull.) P. Kumm., *L. echinella* Quél. & G. E. Bernard, *L. helveola* Bres., *L. lilacina* (Quél.) Boud., *L. micropholis* (Berk. & Broome) Sacc., *L. oreadiformis* Velen., *L. scobinella* (Fr.) Gillet, *L. serena* (Fr.) Sacc., and *L. setulosa* J.E. Lange.

As a result of our investigation, four species of lepiotaceous fungi are reported from Israel for the first time: *Leucoagaricus pilatianus, Lepiota apatelia, L. subgracilis* and *Macrolepiota konradii.*

Materials and methods

Specimens were collected in Israel during the period 2006-2007 and deposited at the Herbarium of the Institute of Evolution, University of Haifa (HAI).

Distribution of species (Figure 1) is noted according to the natural regions of Israel as defined by Feinbrun-Dothan & Danin (1998). Species concepts and tribe circumscriptions follow Wasser (1985, 1989, 1993). General ecological information is drawn from Wasser (1993), Guzmán & Guzmán-Dávalos (1992), and Vellinga (2001). Micromorphological characteristics of our specimens were observed using Melzer's reagent, Congo red, cotton blue and Cresyl blue.

Results

Four new records of lepiotaceous fungi are added to the mycobiota of Israel; these are: *Leucoagaricus pilatianus, Lepiota apatelia, L. subgracilis* and *Macrolepiota konradii,* one of these, *Lepiota apatelia* is a new record for Asia. Our investigations also show that species are found primarily in *Quercus, Eucalyptus,* and *Pinus* groves of northern Israel.

Taxonomy

Leucoagaricus pilatianus (Demoulin) Bon & Boiffard,
Doc. Mycol. 6(24): 45. 1976 **Figure 2**

Bas.: *Lepiota pilatiana* Demoulin, Lejeunia, n.s. 39: 11. 1966.

Syn.: *Lepiota rufovelutina* var. *sanguinescens* Pilát, Sborn. Nar. Muž. v Praže, 11B(2): 16. 1953.

Lepiota rufovelutina var. *subrubens* Wichanský, Česká Mykol. 14: 49. 1960.

Lepiota pilatiana var. *subrubens* (Wichanský) Demoulin, Lejeunia, n.s. 39: 12. 1966.

Leucocoprinus pilatianus (Demoulin) M.M. Moser, Kleine Kryptogamenflora, 3Aufl. IIb/2: 186. 1967 (nom. inval.).

Leucocoprinus pilatianus (Demoulin) Wasser, Novit. Syst. Plant. Vasc. et non Vasc. 4: 219. 1978.

Leucocoprinus pilatianus var. *subrubens* (Wichanský) Wasser, Nov. Sist. Niz. Rast. 14: 221. 1978 ('1977').

Leucocoprinus badhamii var. *pilatianus* (Demoulin) Krieglst., Beitr. Kenntn. Pilze Mitteleur. 7: 57. 1991.

Leucoagaricus salmoneophyllus Bon & Guinb., Doc. Mycol. 22(88): 31. 1993.

Leucoagaricus pilatianus var. *subrubens* (Wichanský) Migl. & A. Gennari, Riv. Micol. 41(4): 292. 1999 ('1998').

Leucoagaricus pilatianus var. *salmoneophyllus* (Bon & Guinb.) Migl. et A. Gennari, Riv. Micol. 41(4): 293. 1999 ('1998').

Misapplied - *Lepiota rufovelutina* Velen. sensu Pilát, Klič k určovani našich hub: 424. 1951, Sborn. Nar. Muž. v Praže, 11B(2): 12-18. 1953.

Pileus 5–8 cm in diam., convex-applanate, with low umbo, slightly incurved margin, brownish-reddish, toward the center darker, velvety or silky, sometimes almost smooth, with age cracked, flesh between cracks cream-white. Surface on damaging discoloring to reddish, then becoming vinaceous-brownish, brown. Lamellae free, with collarium, thin, crowed, slightly ventricose, whitish or light cream-colored with a concolorous fimbriate edge, on handling staining

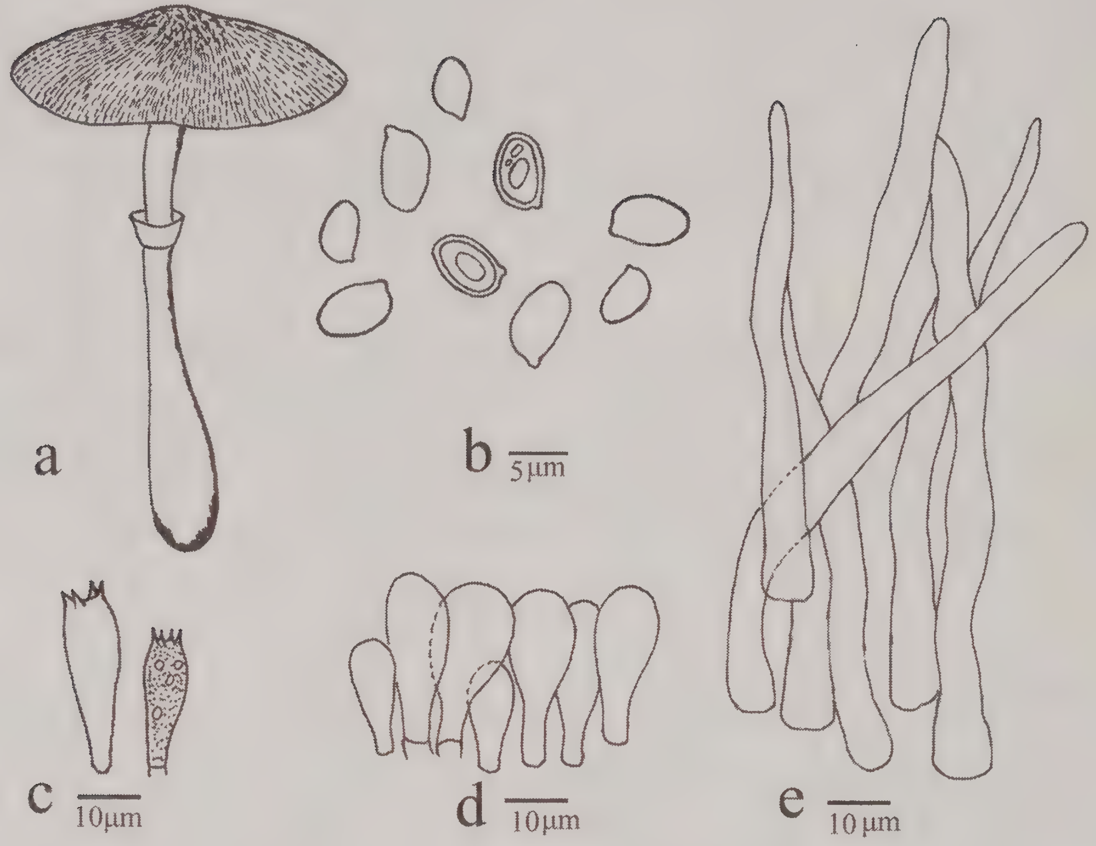

Figure 2: *Leucoagaricus pilatianus* (HAI 343).
a – basidiomata, b – basidiospores, c – basidia, d – cheilocystidia, e – elements of the pileipellis

reddish, on drying light pink. STIPE 6–11×0.8–1.0 cm, central, straight, hollow, sometimes twisted, cylindrical, up to 0.5 cm wide at apex and gradually bulbous 1.5 cm wide base, white and smooth above annulus, and brownish-reddish, solid, smooth, silky, shiny, slightly fibrillose under ring. RING situated 6–7 cm above stipe base, sometimes in the middle of the stipe, simple, 0.5–0.7 cm wide, infundibuliform, whitish, with a dark brown margin, stable. CONTEXT fleshy, whitish, on exposure becoming red, without smell, taste none. SPORE PRINT whitish.

BASIDIOSPORES 5.5–9×3.5–4.5 µm, ovate to ellipsoid, sometimes amygdaloid, with a lateral apiculus, with a germ pore, which is often invisible, colorless, smooth, thin walled, weakly dextrinoid, congophilous, cyanophilous, metachromatic. BASIDIA 4-spored, 17–25×6.0–8.0 µm, clavate, hyaline, mostly thin-walled. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA (21)28–43×8.0–12(13–14) µm, variable in shape, mostly clavate, without apical excrescences, smooth, not pigmented. HYMENOPHORAL TRAMA irregular. PILEIPELLIS consisting of densely packed, long erect cystidioid hairs, 80–350×5–15 µm, wide in base, gradually narrow at apex; apex rounded, with pale yellowish, brownish, pinkish pigment. Almost all hyphae are incrusted with reddish-brownish crystals. STIPITIPELLIS consists of long cylindrical pale colored hyphae 3–10 µm in wide. CLAMP-CONNECTIONS absent.

SPECIMENS EXAMINED: **Israel.** GH: Ein Teo, in *Eucalyptus* groves, leg. Y. Ur, 21.02.07, det. A. Kosakyan (HAI 343) (Figure 6).

HABITAT AND DISTRIBUTION: Solitary to gregarious in small groups, saprotrophic in soil, in deciduous copse on loamy nutrient-rich soil. Known from EUROPE: British Isles, Belgium, Ukraine, France, Italy, Austria, Hungary, Czech Republic, Slovak Republic, Romania, Spain, Russia (North Caucasus); ASIA: Israel (first record), Georgia (Caucasus); AFRICA: Morocco.

DISCUSSION: *Leucoagaricus pilatianus* is a rare species for Asia. First recognized as *Lepiota rufovelutina* Velen. sensu Pilát, the taxon was found to have features in conflict with the concept of *L. rufovelutina* var. *subrubens* as described by Wichanský (1960) by Demoulin (1966), who transferred it to *L. pilatiana* var. *subrubens.* Moser (1967) later transferred *Lepiota pilatianus* to *Leucocoprinus* based on the presence of germ pore in spores and differences in microchemical reactivity and pileipellis. Vellinga (2001) next transferred *Leucocoprinus pilatianus* to *Leucoagaricus* based on differences in habitus of pileus, heteromorphic basidia, presence of pseudoparaphyses; this transfer was also supported by molecular data. *Leucoagaricus salmoneophyllus* was recently described (Bon & Guinberteau 1993) as an independent species based on its small habitus, smell, and different tint; Gennari & Migliozzi (1999), who regarded these differences as varietal, proposed *Leucoagaricus pilatianus* var. *salmoneophyllus* (Gennari & Migliozzi 1999) for the taxon, now regarded as synonymous with *Leucoagaricus pilatianus.*

Relatively larger spores and basidia distinguish our specimens from those of Demoulin (1966). The specimens described by Candusso & Lanzoni (1990) have smaller pilei, shorter stipes, more variable and larger cystidia. In Wasser (1993), specimens are described as thin, without umbos, and with more variable cystidia and pleasant smell and taste. Basidiospores from specimens collected in The Netherlands are more ellipsoid than amygdaloid (Vellinga 2001) while larger fleshy pilei, more amygdaloid basidiospores, and longer pileal elements distinguish specimens described from Canaria (Bañares & Beltran 1981).

La. pilatianus is most closely related to *La. badhamii,* from which it differs by the absence of pigmentation in cheilocystidia, cheilocystidial shape, and stipitipellis hyphal structure. The problem of species independence of *La. pilatianus* and *La. badhamii* and differences in the ecology and distribution is discussed in detail by Demoulin (1966), Josserand (1974), Candusso & Lanzoni (1990), Wasser (1993). *Leucoagaricus pilatianus* is also close to *La. aurantiovergens* A. Gennari & Migl. (Gennari & Migliozzi 1999), described

Table 1. Important distinguishing characteristics of *Leucoagaricus pilatianus* and related *Leucoagaricus* species

Species	*La. pilatianus*	*La. badhamii*	*La. jubilaei*	*La. aurantiovergens*	*La. melagris*	*La. georginae*
Reference	Personal observation	Candusso &Lanzoni 1990	Reid 1990	Gennari & Migliozzi 1999	Vellinga 2001	Wasser 1993
Pileus (*P*) & Stipe (*S*) [in cm]	*P* 5.0–8.0 *S* 6.0–11.0 × 0.8–1.5	*P* 5.0–8.0 *S* 8.0–12.0 × 0.5–1.0	*P* 2.5–4.5 *S* 3.0–6.0 × 0.4–1.0	*P* 3.0–6.0 *S* 5–80 × 0.5–1.5	*P* 1.3–8.0 *S* 2.0–6.5 × 0.3–1.2	*P* 1.0–2.5 *S* 1.5–4.5 × 0.2–0.3
Context [color after exposure]	Red	Fleetingly red	First yellow, then red	Orange (stipe only)	Yellow, then red, then vanishing	Red
Spores [in µm]	5.5–9 × 3.5–4.5	6.0–8.5 × 3.5–4.7	6.0–8.0 × 3.5–4.5	7.0–10.0 × 3.4–5.0	7.5–11.5 × 5.5–8.0	6.0–8.0 × 3.0–4.5
Cystidia [in µm]	(21)28–43 × 8–12(14) hyaline	30–60×20 apical rame, brown granules	20–46(6) × 8–15	35–60 × 8–16 clavate-cylindrical	20–65 × 8–17	30–60 × 10–16 lanceolate with apical elongation
Pileipellis elements [in µm]	Long erect cystidioid hairs (80–350 × 5–15)	Long (100–400 × 10–20) (short cells intermixed)	Clavate-cylindric elements 40–200 × 6–20)	Trichoderm with clavate-cylindric elements	Long (50–170 × 10–20) (short cells intermixed)	Trichoderm with clavate-cylindric elements

from Italy, from which it differs by basidiospore size, cystidia, and discoloration of stem to orange when scratched. *La. pilatianus* differs from *La. jubilaei* (Joss.) Bon in size, cystidial shape, and context discoloration when cut (Wasser 1993). Table 1 compares *Leucoagaricus pilatianus* and related species.

Lepiota apatelia Vellinga & Huijser,
Belg. J. Bot. 131: 196. 1999 ('1998') **Figure 3**

Misapplied- *Lepiota cristatoides* sensu Bizio et al., Riv. Micol. 36: 226-227. 1993; sensu Huijser & Vellinga, Arnolds et al., Overz. Paddest. Nederland: 290-291. 1995; sensu Kelderman, Parasolzw. Zuid-Linburg: 132-133. 1994; sensu Vellinga & Huijser, Coolia 40: pl. 3. 1997.

Pileus 1.5–2 cm in diam., plano-convex to applanate, with low umbo, slightly incurved edge, orange brown to yellow-brownish, with little darker center, around center breaking up into concentrically arranged adnate patches, with faintly velar remnants at the margin. Lamellae free, thin, crowded, cream-yellowish, with slightly pink tinge, with eroded whitish edge. Stipe 3–3.5×0.2–0.3 cm, with 0.4–0.5 cm wide base, cylindrical, smooth, hollow, cream, from up to base discoloring slightly brown-reddish, which is vanishing later on. White

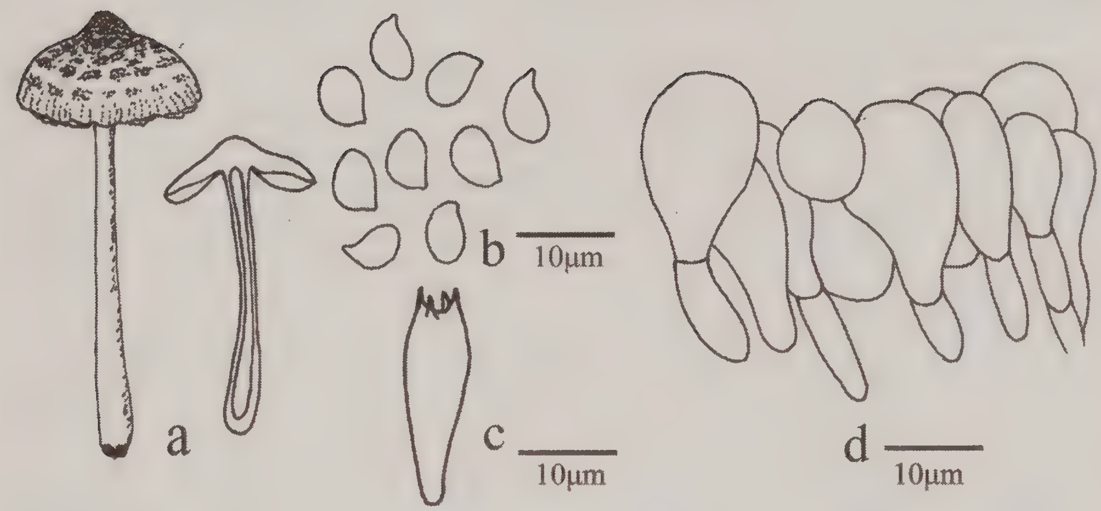

Figure 3: *Lepiota apatelia* (HAI 33).
a – basidiomata, b – basidiospores, c – basidium, d – elements of the pileipellis.

mycelial cord on the base. RING white, very membranous, not distinct and removed very easily. CONTEXT whitish-cream, in base brownish, with strong unpleasant smell, taste is unknown. SPORE PRINT whitish.

BASIDIOSPORES 5–7×3.5–4.5 µm, ellipsoid to oblong, with small lateral apiculus, pale brown in Melzer's reagent, weakly metachromatic. BASIDIA 4-spored, 22–30×7–9 µm, clavate, thin-walled. CHEILOCYSTIDIA and PLEUROCYSTIDIA absent. HYMENOPHORAL TRAMA regular. PILEIPELLIS consisting of hymeniderm, made up of clavate terminal thick-walled elements, 12–35×8–10 µm, colored to weakly brown intercellular pigment. STIPITIPELLIS consists of cylindrical long colorless hyphae with 3–4 µm wide. CLAMP-CONNECTIONS present.

SPECIMENS EXAMINED: **Israel.** UG: Safsufa forest, under *Quercus calliprinos*, leg. Y. Ur, 19.11.06, det. A. Kosakyan (HAI 33) (Figure 6).

HABITAT AND DISTRIBUTION: Gregarious, often in big groups, saprotrophic in soil, in deciduous woods, also mine waste heaps. Known from EUROPE: the Netherlands, Austria, Germany, Italy; ASIA: Israel (first record).

DISCUSSION: *Lepiota apatelia* is a very rare species that Vellinga & Huijser (1999) described recently from the Netherlands. *Lepiota apatelia* has often been misidentified (e.g., Bizio et al. 1993, Kelderman 1994, Vellinga & Huijser 1997), and in literature sometimes we can find it as *Lepiota cristatoides. Lepiota apatelia* is macroscopically very similar to *L. cristata,* from which it is easily distinguished by shape of spores, absence of distinct annulus, and a different smell. It is also very close to *L. cristatoides,* from which it differs by size, non-smooth, orange-brown pileus, absence of annulus, and basidiospore

Table 2. Important distinguishing characteristics of *Lepiota apatelia* and related *Lepiota* species

Species	L. apatelia	L. cristata	L. cristatoides	L. hymenoderma	L. thiersii
Reference	Personal observation	Wasser 1980	Vellinga 2001	Candusso & Lanzoni 1990	Sundberg 1989
Pileus (*P*) & Stipe (*S*) [in cm]	*P* 1.5–2 *S* 3–3.5 × 0.2–0.5 ring not distinct	*P* 1.5–5 *S* 2.5–7 × 0.2–0.5 ring distinct	*P* 0.9–3.0 smoother, pinker *S* 1.5–5 × 1–3 ring distinct	*P* 1.6–2.5 *S* 3–6.5 × 0.18–0.27 without ring	*P* 0.8–4 *S* 3.0–6.0 × 0.25–0.5 fibrillose zone, no ring
Context (*P* = pileus; *S* = stipe)	*P* whitish *S* brown-reddish Odor of strong rubber;	*P* whitish *S* pinkish Odor of strong rubber; taste unpleasant	*P* whitish *S* pinkish Odor of strong rubber	*P* white to cream *S* orangish Odor both fruity & rubberlike	*P&S* white & unchanging Odor & taste farinaceous
Spores [in µm]	5–10 × 2.5–3.5 truncate, narrowly triangular, metachromatic	6–8.5 × 2.5–3 ellipsoid, pale	3.5–5.5 × 2.5–3.5 ellipsoid to oblong, metachromatic	4.5–6. × 2.5–3 ellipsoid to oblong, metachromatic	4.7–6.3 × 3–3.9 ovoid-ellipsoid, not dextrinoid
Pleurocystdia	absent	absent	absent	absent	absent
Cheilocystdia	absent	presen	absent	present	absent

microchemical reactions. The also close *Lepiota thiersii* Sundb., described from California (Sundberg 1989), produces nondextrinoid basidiospores, a less well-developed velium partiale, clavate to spheropedunculate pileipellis elements, and farinaceous smell. *Lepiota apatelia* and related species are compared in Table 2.

Lepiota subgracilis Kühner ex Wasser,
Ukr. Bot. J. 35(5): 517. 1978 **Figure 4**

Syn.: *Lepiota gracilis* (Quél.) J.E. Lange, Dansk bot. Ark. 2(3): 24. 1915, nom. illegit., *Lepiota gracilis* Peck 1899.
Lepiota subgracilis Kühner, Bull. Soc. Mycol. France 52: 231. 1936 (nom. inval.).
Lepiota kuehneriana Locq., Friesia 5: 296. 1956.
Lepiota latispora (Kühner ex Wasser) Bon, Doc. Mycol. 11(43): 30. 1981.
Misapplied- *Lepiota gracilis* sensu J.E. Lange, Flora Agaricina Danica I: 28. 1935, non sensu Locq. Bulletin Soc. Linn. Lyon 14: 50. 1945.

Pileus 1.8 cm in diam., thin, fleshy, first campanulate, after expanding to plano-convex, with low umbo, at center dark red-brown, with small dense fibrills,

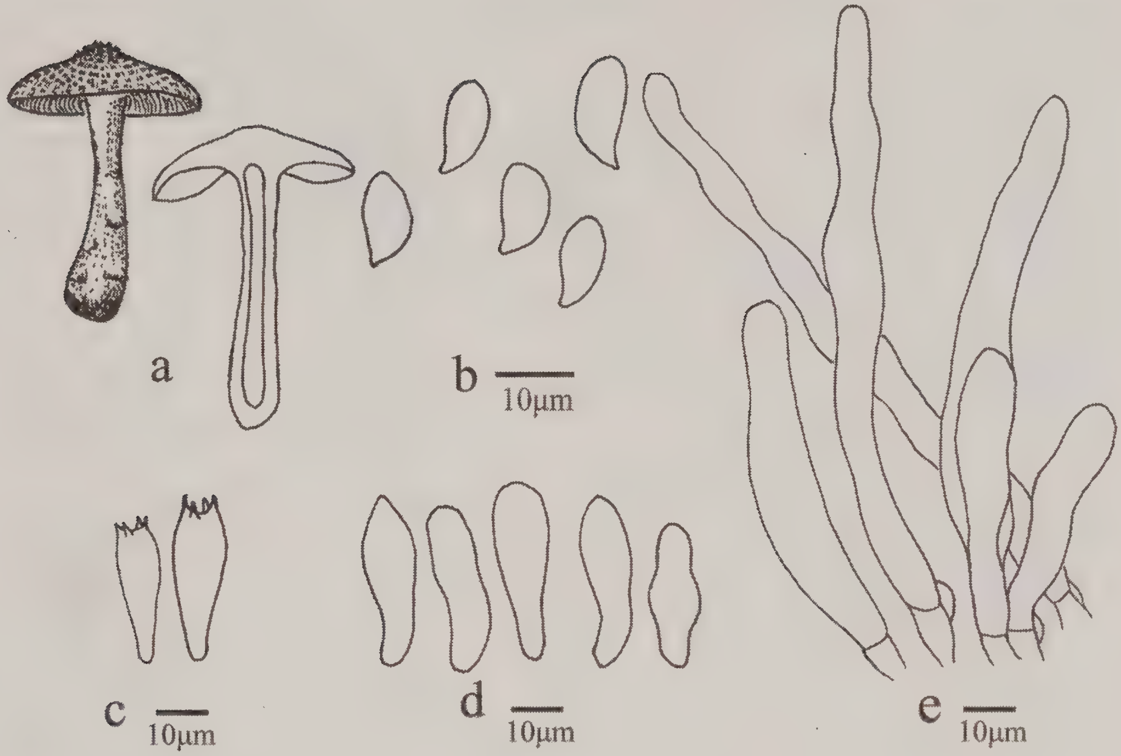

Figure 4: *Lepiota subgracilis* (HAI 328).
a – basidiomata, b – basidiospores, c – basidia, d – cheilocystidia, e – elements of the pileipellis

paler near margin, with brownish granular squamules, on whitish-ochraceous background. Lamellae free, crowded, wide, creamy white, cream-colored, very pale grey brown with age, with finely serrate to almost even, white age. Stipe 3.0×0.4 mm, cylindrical, slightly enlarging at the base, hollow, cream to pale ochraceous, with lilaceous tinge, fibrillose or squamulose at base. Ring usually present as white wooly remnants of the partial veil, but not distinct, and disappearing soon after collection. Context whitish in pileus, concolorous with surface and shiny in stipe. Without smell and taste. Spore print whitish.

Basidiospores 10.5–11.5×4.5–5 µm, amygdaliform to oblong, with lateral apiculus, dextrinoid, congophilous, metachromatic. Basidia 4-spored, 20–30×7–12 µm, clavate. Pleurocystidia absent. Cheilocystidia 20–45×7–12 µm, variable in shape, cylindrical, clavate, lageniform, utriform, colorless. Hymenophoral trama regular. Pileipellis with elongated elements 50–300×6–12 µm, some hyphae with one septa and brownish walls. Stipitipellis made up of long cylindrical hyphae 7–10 µm wide. Clamp connections present.

Specimens examined: **Israel.** CM: Ramat Hanadiv, in *Pinus* groves, leg. Y. Ur, 19.02.07, det. A. Kosakyan (HAI 328) (Figure 6).

Habitat and distribution: Solitary or in small groups, saprotrophic in soil, on clayey soils, often rich in nutrients, in deciduous woods. Known from

TABLE 3. *Lepiota subgracilis* characters as published by different authors

REFERENCE	CURRENT PAPER (2008)	WASSER (1980)	CANDUSSO & LANZONI (1990)	VELLINGA (2001)
PILEUS (*P*) & STIPE (*S*) [in cm]	*P* 1.8 *S* 3 × 0.4	*P* 2–4 *S* 2–5 × 0.2–0.5	*P* 1.5–3.5 *S* 2–4.5 × 0.3–0.6	*P* 2–4.8 *S* 4–9 × 0.2–0.65
PILEIPELLIS ELEMENTS [in µm]	Elongated (50–300×6–12), some hyphae with one septum; basal clavate elements with brownish walls	——	Elongated (100–400×8–13); clavate on base (30–50×8–14) with brownish walls	Elongated (55–360×8-13) with 0–1 septa & grey-brown walls; with/without basal clavate elements
STIPITIPELLIS HYPHAE	Long, cylindrical, 7–10 µm diam	——	——	Long, cylindrical walls pale yellow 4–6 µm diam
SPORES [in µm]	10.5–11.5×4.5-5 amygdaliform to oblong, apiculus lateral	9–12 × 4.5–6 fusiform-ellipsoid, apiculus lateral	10–14 × 4.5–5 subfusiform to slightly ellipsoid apiculus lateral	9–13.5 × 4–6.5 amygdaliform to oblong, broadly fusiform or ovoid
CHEILOCYSTIDIA [in µm]	20–45×7–12 cylindrical, clavate, lageniform, utriform	23–26×6–8 clavate	20–27×7–14 lageniform, ventricose	15–43×6.5–11 cylindrical, subcapitate, narrowly clavate, lageniform to utriform
ODOR	Odorless	Pleasant, quickly disappearing	Occasionally slightly fungoid	Not distinct, when old reminiscent of *L. cristata*

EUROPE: British Isles, the Netherlands, Italy, France, Czech Republic, Hungary, Ukraine. ASIA: Russia (Far East-Primorye Territory), Sri-Lanka, Israel (first record). NORTH AMERICA: USA. SOUTH AMERICA: Argentina.

DISCUSSION: *Lepiota subgracilis* is relatively common throughout the world. Kühner (1936) considered the name used by Lange (1935) *L. gracilis* as *L. subgracilis*, to be invalid based on a missing Latin diagnosis. The validation by Wasser (1978) is considered to be the accepted citation (Candusso & Lanzoni 1990). *Lepiota kuehneriana* and *L. latispora* are considered synonyms of *L. subgracilis*, because their type specimens differ only in larger size and distinct smell (Locquin 1956, Bon 1981).

Lepiota subgracilis is quite variable. Our specimens have smaller pilei and larger, more variable cystidia than those described in Wasser (1980). Specimens described by Candusso & Lanzoni (1990) have relatively smaller spores, while those described by Vellinga (2001) have larger pilei and stipes, larger basidiospores, and shorter, narrower pileipellis hyphae. Detailed descriptions of *L. subgracilis* as given by different authors are compared in Table 3.

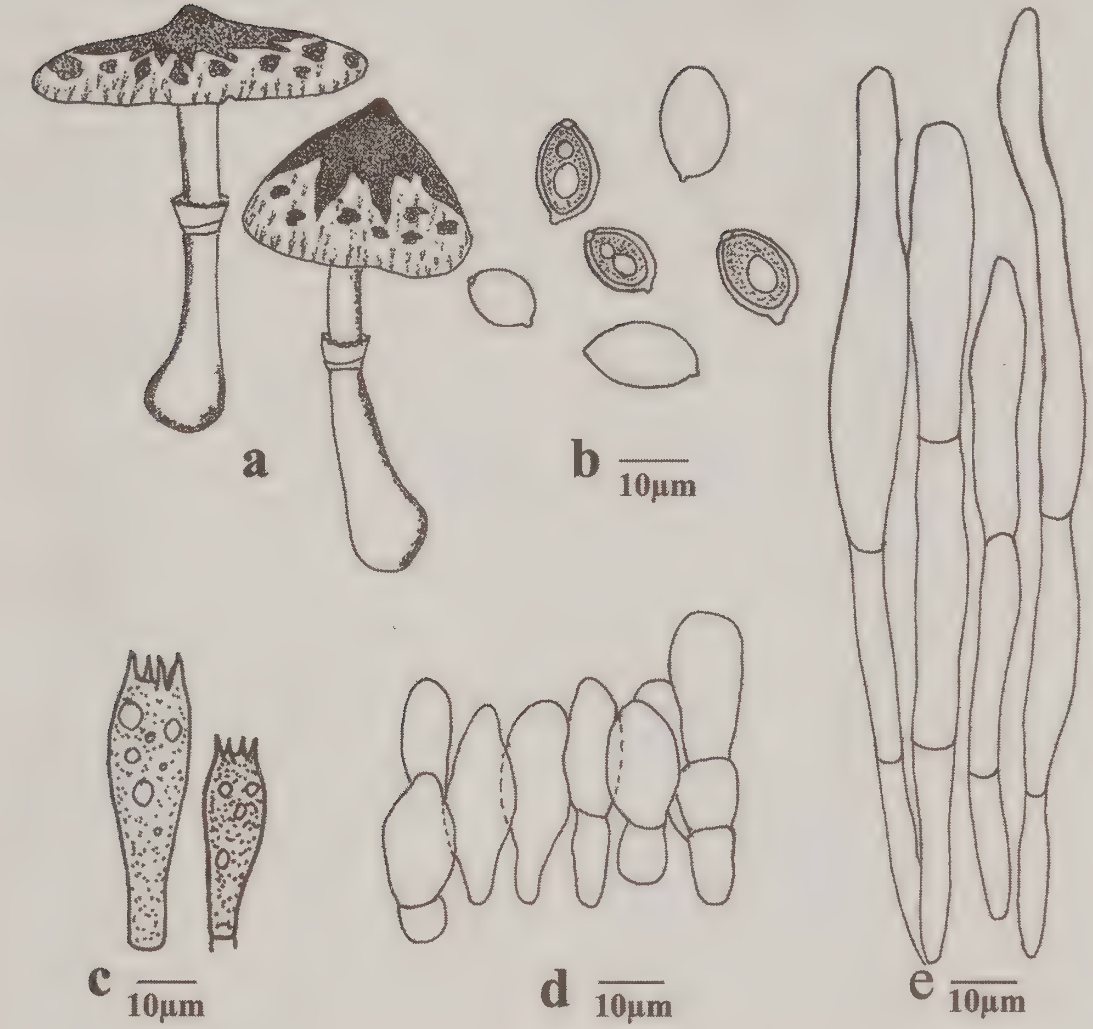

Figure 5: *Macrolepiota konradii* [HAI 200(M), 205, 294].
a – basidiomata, b – basidiospores, c – basidia, d – cheilocystidia, e –elements of the pileipellis

Macrolepiota konradii (Huijsman ex P.D. Orton) M.M. Moser,
Kleine Kryptogamenflora, 3Aufl., IIb/2: 185. 1967 **Figure 5**

Bas.: *Lepiota konradii* Huijsman ex P.D. Orton, Trans Brit. Mycol. Soc. 43: 283. 1960.

Syn.: *Lepiota excoriata* var. *konradii* Huijsman, Medded. Nedl. Mycol. Ver. 28: 18. 1943. (nom. inval.).

Leucocoprinus maublancii Locq., Bull. mens. Soc. Linn. Lyon, 14: 92. 1945.

Misapplied- *Lepiota excoriata* subsp. *mastoidea* sensu Konrad & Maublanc, Icons Selectae Fungorum I: Pl. 10. 1928.

Lepiota gracilenta sensu Rea, Brit. Basidiom.: 66. 1922.

Pileus 5–11 cm in diam., fleshy, when young hemispherical to campanulate, later convex-applanate, with low umbo, pileal surface towards the margin without pellicle, whitish, grey, dingy-grey-brownish, thin-silky-fibrillose, surface layer disrupted on asteroid manner, in the centre dark umbrous, sometimes black-brown, pinkish-brownish. Pileal margin straight, incurved in old specimens,

Table 4. Important distinguishing characteristics of *Macrolepiota konradii* and related *Macrolepiota* species

Species	*M. konradii*	*M. mastoidea*	*M. rickenii*	*M. affinis*	*M. fuligineo-squarrosa*
Reference	Personal observation	Candusso & Lanzoni 1990	Candusso & Lanzoni 1990	Candusso & Lanzoni 1990	Didukh et al. 2002
Pileus [in cm]	5–11 umbo low, disc umbrous, to black-brownish; margins whitish to grey, surface disrupted in asteroid fashion	8–12 umbo sharply protruding, dark disc scales appressed fine floccose; margins whitish, cracked	6–12 disc umbonate & with light brown scales	5–12 umbo acute, brownish-pink scales on disc; margins creamy cracked,	6–8 umbo obtuse, cuticle breaks to form central patch surrounded by small concentric squamules on light brown ground
Pileipellis — trichoderm elements [in µm]	Long (50–300 × 9–15), cylindrical, intercellular pigments brownish, incrusted toward base	Long (80–180 × 6–12), cylindrical, walls with/ without pale incrustations	Cylindrical (8–14 diam), walls with/ without pale incrustations	Long, cylindrical (6–12 diam), pigments intercellular, non-incrusting	Disc elements terminal (112.5–200 × 15–22.5) & palisade (117.5–125 × 12.5–17.5); Margin elements cylindrical
Stipe [in cm]	7–15.5 × 0.5–1.5 (2.5–3 at base)	11–16 × 0.3-1.1 (1.5–2.2 at base)	10–16 × 1–2 (2-2.5 at base)	7–13 × 0.6–1 (small bulb at base)	8–10× 1–1.5 , (≤2.7 diam basal bulb)
Spores [in µm]	11.4–15.5(20) × 7–9.2(10) ellipsoid, ellipsoid-ovate	11–16.5(19) × 7.5–10.5 ellipsoid	12–17 × 7.5–10 ellipsoid	10–16(20) × 7–9.5(11) ellipsoid	12.5–17 × 7.5–10 ovoid, subelliptic, almond-shaped
Cheilo-cystidia [in µm]	17–40 × 10–13 clavate, subfusiform	20–50 × 12–15 fusiform	15–33 × 6–15 ventricose-subfusiform	20–45 × 8–15 ventricose-fusiform	45–50 × 10–15 slightly clavate, fusiform

on drying undulate. Lamellae free, with small collarium, crowded, broad, with even edge, easily separating from pileus, white, later pale creamy. Stipe 7–15.5×0.5–1.5 cm, central, cylindrical, sometimes slightly twisted, enlarged up to 2.5–3 cm at the base, solid, brownish, grooved, sometimes covered with umbrous adpressed scales, formed by cracking of the surface layer. Ring apical, wide, double crown, upper side brown, underside creamy, easily separating, mobile, often with bifurcate edge. Context dense, white-creamy, unchanging on exposure. Smell and taste pleasant fungal. Spore print whitish-creamy.

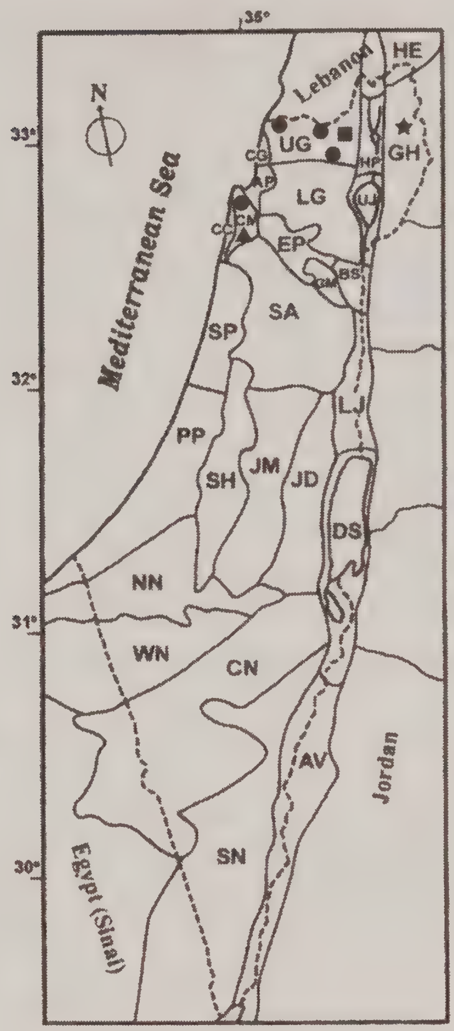

Figure 6: Distribution of *Leucoagaricus pilatianus, Lepiota apatelia, L. subgracilis* and *Macrolepiota konradii* in Israel.

★ – *Leucoagaricus pilatianus*
■ – *Lepiota apatelia*
▲ – *Lepiota subgracilis*
● – *Macrolepiota konradii*

Basidiospores 11.4–15.5(20)×7–9.2(10) μm, ellipsoid, ellipsoid-ovate with a germ pore, with hyaline cap (sometimes slightly visible), with lateral apiculus, with a large refractive droplet, smooth, thick-walled, dextrinoid, congophilous, cyanophilous, metachromatic. Basidia 4-spored, 30–50×10–12(14) μm, clavate. Pleurocystidia absent. Cheilocystidia 20–40×10–13 μm, clavate, subfusiform. Hymenophoral trama irregular. Pileipellis as a trichoderm, with long cylindrical elements, 50–200×9–14 μm, with intercelular brownish pigment, often incrusted at base. Stipitipellis with narrow cylindrical colorless hyphae, 3–10 μm wide, with a brown pigment. Clamp-connections present.

Specimens examined: **Israel.** UG: Mt. Meron, National Park, under *Pinus,* leg. Y. Ur, 14.01.2005, det. S.P. Wasser. UG: Near Mt. Meron, under *Quercus* and *Pinus,* leg. Y. Ur, 03.01.2005, det. S.P. Wasser. CM: Derex Nof Carmel, in *Quercus* groves, leg. Y. Ur, 19.01.2007, det. A. Kosakyan. UG: Goran Park, leg. Y. Ur, 9.02.07, det. A. Kosakyan [HAI 200(M), 205, 294] (Figure 6).

Habitat and distribution: Solitary or in small groups, in broad-leaved and mixed forests, parks, often meadows and fields. Known from Europe: British Isles, Denmark, Belgium, Switzerland, the Netherlands, France, Italy, Hungary, Austria, Germany, Czech Republic, Slovak Republic, Romania, Poland, Ukraine, Belarus, Moldova. ASIA: Russia (Far East-Primorye Territory), Viet Nam, Israel (first record).

DISCUSSION: Konrad & Maublanc (1924-37) treated the species as *Lepiota excoriata* subsp. *mastoidea.* Huijsman (1943) renamed the taxon *Lepiota excoriata* var. *konradii* in honor of the Swiss mycologist but provided no Latin diagnosis. Locquin (1945), not knowing about Huijsman's publication, renamed the same fungus as *Leucocoprinus maublancii.* Orton (1960) proposed *Lepiota konradii,* which Moser (1967) later transferred to *Macrolepiota.* Vellinga (2001) considers *Macrolepiota konradii* identical to *M. mastoidea* and *M. rickenii,* which differ from each other only in pileus color; she also cites molecular evidence supporting the group as one taxon (Vellinga, 2001). However, as there are obvious morphological differences in habitus, size and shape of pileal elements, and pileus color and form, we choose to treat the three as independent species pending further studies. Table 4 compares *M. konradii* and its related species.

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Literature cited

Avizohar-Hershenzon Z. 1967. *Chlorophyllum molybdites* (Meyer: Fr.) Massee in Israel. Isr. J. Bot. 16: 63-69.

Babos M. 1979. The species of the "Rubentes" group in the genus *Leucocoprinus.* Sydowia 8: 33-53.

Banares B, Beltran T. 1981. Additions to the Canarian mycologic flora I. Anales Jard. Bot. 39(1): 19-30.

Binyamini N. 1973. White-spored Agarics new to Israel. Isr. J. Bot. 22: 38-46.

Binyamini N. 1974. Fleshy fungi of north and central Israel I. Isr. J. Bot. 23: 237-251.

Binyamini N. 1975. Fleshy fungi of north and central Israel (*Agaricales*). Publ. House Ltd: Tel Aviv (Israel). 227 pp.

Binyamini N. 1976a. Fleshy fungi of north and central Israel II. Isr. J. Bot. 25: 62-78.

Binyamini N. 1976b. Fleshy fungi of north and central Israel III. Nova Hegwigia 27: 861-876.

Binyamini N. 1976c. Rare and interesting records of Israel Agaric flora. Nova Hegwigia 28: 759-770.

Binyamini N. 1984. Rare and interesting records of Israel Agaric Flora II. Nova Hegwigia 40: 59-65.

Binyamini N. 1989. Rare and interesting records of Israel Agaric Flora IV. Opera Bot. 100: 23-27.

Bizio E, Migliozzi V, Zecchin G. 1993. La sezione Integrellae (Kühner ex Bon) Bon del genere *Lepiota* (Persoon) Gray. Riv. di Micol. 36(3): 223-244.

Bon M. 1981. Clé monographique des "Lepiotes" d'Europe. Doc. Mycol. 11(43): 1-77.

Bon M, Guinberteau. 1993. *Leucoagaricis salmoneophyllus* sp. nov. Doc. Mycol. 22(88): 31.

Candusso M, Lanzoni G. 1990. *Lepiota* s.l. Fungi Europeai. 4. Libreria editrice Giovanna Biella: Saronno (Italy). 743 pp.

Demoulin V. 1966. Le probleme de *Lepiota badhami* et de *Lepiota rufovuletina.* Revue de Botanique 39: 1-15.

Didukh M, Wasser S, Nevo E. 2002. New records of *Leucocoprineae* and *Lepioteae* (*Basidiomycotina, Agaricales* s.l) in Israel. Doc. Mycol. 126: 39-58.

Didukh M, Wasser S, Nevo E. 2004. Genus *Chamamyces (Agaricaceae)* in Israel. Mycologica Balcanica 1: 89-94.

Feinbrun-Dothan N, Danin A. 1998. Analytical Flora of Eretz-Israel. 2nd edn. Publ. House CANA: Tel Aviv (Israel). 1008 pp.

Gennari A, Migliozzi V. 1999 ('1998'). Una nuova entità della sezione Piloselli *Leucoagaricus aurantiovergens* sp. nov. Riv. Micol. 41(4): 291.

Guzmán G, Guzmán-Dávalos L. 1992. A checklist of the lepiotaceous fungi. Koetz Scientific Books, Champagains (U.S.A.). 216 pp.

Huijsman H. 1943. Observations sur le "genere" *Lepiota.* Mededeelingen van de Nederlandsche. Mycologische Vereeniging 28: 1-60.

Josserand M. 1974. Une nouvelle espéce de lepiote rougissante: *Lepiota jubilaei* petite étude du groupe. Numero Spec. Bull. Soc. Linn. 43: 205-216.

Kelderman P. 1994. Parasolzwammen van Zuid-Limburg. Nederland. *Lepiota* s.l. excl. *Macrolepiota.* Natuurhistorisch Genootschap: Limburg (Nederland). 207 pp.

Konrad P, Maublanc A. 1924-37. Icones Selectae Fungorum 1-5: pl. 1-500.

Kühner R. 1936. Recherches sur le genre *Lepiota.* Bull. Soc. Mycol. Fr. 52: 175-238.

Lange J. 1935. Flora Agaricina Danica. I. Copenhagen. 92 pp.

Locquin M. 1945. Notes sur les *Lepiotes* II. Bull. Soc. Linn. Lyon 14: 3-40.

Locquin M. 1956. Quelques *Lépiotes* nouvelles ou critiques. Friesia 5: 293-296.

Moser M. 1967. Die Röhrlinge und Blätterpilze *(Agaricales).* 3 Aufl. Gustav Fisher: Jena. (Germany). 443 S.

Orton P. 1960. New list of British Agarics and Boleti. III. Notes on genera and species in the list. Transactions British Mycological Society 43: 282-290.

Reichert I, Avizohar-Hershenzon Z. 1953. Poisonous mushrooms of Israel. Proc. Staff Meeting Beilison Hospital 122: 116-122.

Reichert I, Avizohar-Hershenzon Z. 1955. Fungi of forest and wood in Israel. Hayaar 4: 1-18.

Reichert I, Avizohar-Hershenzon Z. 1959. A contribution to the knowlige of higher fungi of Israel. Bull. Res. Counc. Isr. 71: 222-241.

Reid D. 1990 The *Leucocoprinus badhamii* complex in Europe: species which redden on bruising or become green in amonia fumes. Mycol. Res. 94(5): 641-670.

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th ed., Koeltz Sci. Books: Koeningstein (Germany). 981 pp.

Sundberg W. 1989. *Lepiota* sensu lato in California. III. Species with a hymeniform pileipellis. Mycotaxon 34: 239-248.

Vellinga E. 2001. Genera *Macrolepiota, Leucocoprinus, Leucoagaricus, Lepiota,* in Flora Agaricina Neerlandica. Publishers Lisse/Abingdon/Exton(PA): Tokyo (Japan). 169 pp.

Vellinga E, Huijser H. 1997. Parasolzwammen in geuren en kleuren. Hoe raak ik thuis in de Parasolzwammen. Coolia 40: 244-260.

Vellinga E, Huijser H. 1999 ('1998'). Studies in *Lepiota.* I. Species with a hymeniform pileus covering. Belgian J. of Bot. 131: 191-210.

Wasser S. 1978. Novi taksonomični kombinacii ta novi taksoni v rodini *Agaricaceae* Fr. Ukr. Bot. J. 35(5): 516-518.

Wasser S. 1980. Flora Fungorum RSS Ucrainicae: *Agaricaceae* Cohn. Naukova Dumka: Kiev (Ukraine). 328 pp.

Wasser S. 1985. Family *Agaricaceae* of the USSR. Naukova Dumka: Kiev (Ukraine). 184 pp.

Wasser S. 1989. Tribe *Agariceae* Pat. of the Soviet Union. Koeltz Sci. Books: Koeningstein (Germany). 120 pp.

Wasser S. 1993. Tribes *Cystodermatae* Singer and *Leucocoprinae* Singer of the CIS and Baltic States. IHW-Verlang: Eching (Germany). 105 pp.

Wasser S. 1995. New and noteworthy species of the genus *Agaricus* L.: Fr. emend. Karst. from Israel. Doc. Mycol. 25(98-100): 469-478.

Wasser S. 1996. New, remarkable and rare higher *Basidiomycetes* from Israel. Czech Mycol. 48(4): 237-250.

Wasser S. 1997. A contribution to the taxonomy of the genus *Agaricus* L.: Fr. emend. Karst. (higher *Basidiomycetes*) of Israel. I. Subgenus *Agaricus.* Boll. Gruppo Micol. G. Bresadola 40(2-3): 465-484.

Wasser S. 1998. Species diversity in the tribe *Agariceae* Pat. (higher *Basidomycetes*) of Israel Mycobiota. Isr. J. Pl. Sci. 46(4): 315-330.

Wasser S. 2000. Contribution to the taxonomy and species diversity of the *Agariceae* tribe (higher *Basidiomysetes*) of Israel Mycobiota. Flora Mediterranea 10: 191-221.

Wasser S. 2002. Family *Agaricaceae* (Fr.) Cohn *(Basidiomycetes)* of Israel Mycobiota I. Tribe *Agariceae* Pat. A.R.A. Gantner Verlag K.-G.: Ruggell (Liechtenstein). 212 pp.

Wichanský E. 1960. Nonnulli *Agaricales* rariores vel minuscogniti annis 1958-1959 in Bohemia lecti. Česka Myk. 14(1): 40-49.

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Studies in lichens and lichenicolous fungi: further notes on North American taxa

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Abstract — *Abrothallus hypotrachynae*, *Phaeographis atromaculata,* and *Thalloloma hypoleptum* are reported as new to North America. The generic placement of *Megalaria beechingii* and *M. pulverea* is discussed. Conforming to the new generic concepts in the *Graphidaceae* several new combinations are proposed for North America taxa: *Fissurina illiterata* (for *Graphis illiterata*), *Graphis xylophaga* (for *Graphina xylophaga*), *Leiorreuma explicans* (for *Phaeographina explicans*), *Phaeographis asteroides* (for *Phaeographina asteroides*), and *Platythecium floridanum* (for *Graphis floridana*). *Miriquidica mexicana* is placed in synonymy with *M. scotopholis*, and detailed discussion of the taxon is provided.

1. *Abrothallus hypotrachynae* Etayo & Diederich, Bib. Lich., 84: 16. 2002.

Abrothallus hypotrachynae was described (Etayo 2002) from specimens of *Hypotrachyna* distributed widely in sub-tropical Central and South America. Considering the phytogeographic affinities of the southeastern Coastal Plain of North America (Beeching 2007, Harris 1995, Lendemer 2006) the discovery of this taxon in North America is not surprising. The North American material was found on thalli of the fertile, lividic acid complex containing taxon *Hypotrachyna livida* (Taylor) Hale, which is widespread and common in eastern North America (Brodo et al. 2001). Presently, no other species of *Abrothallus* has been found on *Hypotrachyna* in North America, and thus the lichenicolous fungus can be recognized by its host as well as the small black apothecia that contain K+ blue-green pigments and have a greenish pruina on the disc, and octosporous asci with 2-celled brown ascospores (11-14 x 5.0-5.3µm).

Specimens Examined – **U.S.A. GEORGIA. DEKALB CO.:** Mt. Arabia Trail, near covered bridge, Arabia Mountain Park, 17.xii.2006, *S.Q. Beeching s.n.* (hb. Lendemer). **FLORIDA. LIBERTY CO.:** Torreya State Park, 9.vii.2007, *E.A. Tripp 297 & K. Deregibus* (hb. Lendemer).

2. ***Fissurina illiterata*** (R.C. Harris) Lendemer, **comb. nov.**
MycoBank MB 511041.

Graphis illiterata R.C. Harris, Some Florida Lichens, p. 20. 1990. TYPE: U.S.A. Florida, Duval Co., Big Talbot Island State Park, 17.xii.1987, *R.C. Harris 21236* (NY!, holotype).

Harris (1990) separated *Graphis illiterata* from *G. subnitidula* Nyl. ex Tuck., by its larger ascospores (15-17 x 6-7μm), obscure fissurine lirellae, and ecorticate thallus. Originally reported from Florida (Harris 1990) it has subsequently been reported from North Carolina (Lendemer & Yahr 2004). Staiger (2002) transferred *G. subnitidula* to the genus *Fissurina* and, following her generic concepts *G. illiterata* should also be placed in that genus. The combination is made here.

3. ***Graphis xylophaga*** (R.C. Harris) Lendemer, **comb. nov.**
MycoBank MB 511042.

Graphina xylophaga R.C. Harris, Some Florida Lichens, p. 14. 1990. TYPE: U.S.A. Florida, Duval Co., Big Talbot Island State Park, trail to "Scrubby Bluff", 17.xii.1988, *R.C. Harris 23900* (NY!, holotype).

Due to the generic concepts employed in the *Graphidaceae* at the time of its description, Harris (1990) described this taxon in the genus *Graphina*. Following the generic circumscriptions of Staiger (2002) *Graphina xylophaga* should be placed in the genus *Graphis*. It is characterized by its laterally carbonized non-striate exciple, lack of lichen substances, and hyaline muriform, I+ blue-violet ascospores (65-90 x 20-30μm, 1-(2)/ascus). The combination is made here.

4. ***Leiorreuma explicans*** (Fink) Lendemer **comb. nov.**
MycoBank MB 511163.

Phaeographina explicans Fink, in Hedrick, Mycologia, 25: 313. 1933. TYPE: U.S.A. Alabama, near Montgomery, 1916, *R.P. Burke s.n.* (MICH!, holotype).

For some time the first author (JCL) has been confused as to the identity of *P. explicans* because it is keyed out as lacking norstictic acid in Harris (1995). Examination of the type specimen (and a paratype in NY) revealed the presence of norstictic acid. *Phaeographina explicans*, described by Fink (in Hedrick 1933) from Alabama and Mississippi, U.S.A. is a widespread species in the southeastern United States recognized by its relatively short unbranched lirellae with poorly developed white margins, fully carbonized exciple, inspersed hymenium, brown submuriform ascospores (8/ascus, 24-31 x 9-12μm, 1-2 x 6 celled), and the presence of norstictic acid (although occasional acid deficient specimens are known). In this species, the hypothecium and lower portions of the hymenium become carbonized in addition to the entire exciple, although the degree of carbonization is not as great as that illustrated for other species of *Leiorreuma* by Staiger (2002). As a result of the aforementioned character, following the generic concepts presented by Staiger (2002), the species would seem best placed in *Leiorreuma*. The new combination is made here.

5. ***Megalaria beechingii*** Lendemer, Opuscula Philolichenum, 4: 39. 2007.

TYPE: U.S.A. Georgia, Rabun Co., Lake Burton Wildlife Management Area, 17.ix.2006, *J.C. Lendemer et al. 7700* (NY!, holotype; CANL!, MSC!, UCR!, HB. LENDEMER!, isotypes).

As has been repeatedly discussed (Ekman & Tønsberg 1996, Fryday 2004, Lendemer 2007) the genus *Megalaria* Hafellner, as defined by Ekman & Tønsberg (1996), consists of several groups of related species that could potentially be recognized at the generic level. Ekman (2001) however, found that division of *Megalaria* was not supported by molecular data and thus the genus remained as circumscribed by Ekman & Tønsberg (1996) until Kalb (2007) described the genus *Catillochroma* to accommodate a group of taxa previously referred to *Megalaria*. This group of taxa essentially differs from the type of *Megalaria*, *M. grossa* (Pers. ex Nyl.) Hafellner, in having the exciple composed of an outer layer of prosoplectenchymatous hyphae and an inner layer of "textura intricata" filled with minute crystals and numerous open spaces between the hyphae. The "double" layered exciple of *Catillochroma* contrasts with the uniformly prosoplectenchymatous exciple of *Megalaria grossa*. Among the species transferred to *Catillochroma* was *M. pulverea* (Borrer) Hafellner & E. Schreiner, which is comparable in excipular anatomy and chemistry to the recently described southern Appalachian endemic *M. beechingii*. As a result of this relationship, the first author (JCL) was curious if *M. beechingii* should be transferred to *Catillochroma* as well. Thus, in addition to material of *Catillochroma*, specimens of *M. beechingii*, *M. grossa*, and *M. pulverea* were examined.

The type species of *Catillochroma* is *C. endochroma* (Fée) Kalb (basionym *Lecanora endochroma* Fée), a species that had not previously been treated in the genus *Megalaria*. While all of the species examined share the character of a double layered exciple, the outer layer of the exciple of *C. endochroma* and *C. intermiscens* (Nyl.) Kalb is composed of loose, thick walled hyphae with enlarged terminal cells that swell significantly in KOH. *Megalaria beechingii*, and *M. pulverea* do not share these characters, and rather have an outer layer more comparable to the species remaining in *Megalaria* in consisting of comparably compact thin walled hyphae without the terminal cell enlarged.

In addition to the differences in excipular anatomy, Kalb (2007) stressed that all species of *Catillochroma* contain zeorin in addition to atranorin, whereas

Megalaria in its newly restricted sense lacks zeorin. Of further interest is the fact that all of the species included in *Catillochroma* contain zeorin, whereas the species included in *Megalaria* lack that substance. Unfortunately, the type of *Megalaria* lacks any lichen substances whereas the majority of other species placed in *Megalaria* produce atranorin, a character shared by *Catillochroma*. The chemical disparity between *M. grossa* and the bulk of *Megalaria* mirrors the considerable morphological differences between the type of the genus and the rest of the species currently placed in *Megalaria*. Could a similar situation have occurred in *Catillochroma*, where the type species differs in excipular characters and apothecial pigmentation from some of the species included in the genus? The argument could be made to remove *M. beechingii* to *Catillochroma* as it is clearly distinct from *M. grossa*, but a similar argument could be made for retaining the species in *Megalaria* as it differs significantly from *C. endochroma*.

As is evidenced by the recent discovery of the affinities of *Lecanora endochroma*, and as has been discussed by Fryday (2004), there are additional species of *Megalaria* s. lat. remaining in other genera, as well as several apparently undescribed taxa. The possibility that these unstudied taxa may shed light on the relationship between *M. grossa* and the rest of *Megalaria* as well as *Catillochroma* should be considered. Until the status of these genera is investigated with molecular data, and a detailed study of *Megalaria* is carried out including the species recently described by Fryday (2004, 2007), Lendemer (2007), and Jagadeesh et al. (2007) the first author advocates a conservative approach, recognizing *Catillochroma* with *C. endochroma* as the type and including any species with similar excipular anatomy such as *C. intermiscens*. Concurrently it seems logical to suggest that *M. beechingii*, *M. pulverea*, and any other species with a similar excipular type be retained in *Megalaria* until their generic placement is confirmed with molecular methods.

6. ***Miriquidica scotopholis*** (Tuck.) B.D. Ryan & Timdal,
in Nash et al., Lichen Flora of the Greater Sonoran Region, 2: 363. 2004.

Biatora scotopholis Tuck., Lich. Calif., p. 24. 1866. TYPE: U.S.A, California, sandstone rocks on coast, *H.N. Bolander s.n.* (NY! [Amherst College 73765], lectotype **designated here**).

Lecidea scotopholis (Tuck.) Herre, Proc. Wash. Acad. Sci., 12: 80. 1910.

Psora scotopholis (Tuck.) Fink, Lich. Flora of the United States, p. 213. 1935.

Psorula scotopholis (Tuck.) Gotth. Schneid., Bib. Lich., 13: 141. 1980 "1979".

Lecanora scotopholis (Tuck.) Timdal, Nord. J. Bot., 4(4): 539. 1984.

Syn. nov. *Miriquidica mexicana* Rambold, Sipman & Hertel, Mycotaxon, 58: 319. 1996. TYPE: MEXICO, Baja California, 23 km SE of El Rosario along Route 1, 78 km on road from San Quintín to Parador Punta Prieta 30°02'N 115°31'W, 200 m., 5.i.1989, *H. Sipman 24923* (B!, holotype)

Though common in central and southern California as well as Baja California, *Miriquidica scotopholis* is rarely collected, partly because many thalli are sterile. It can be mis-determined as a member of the *Lecidea atrobrunnea* group or as *Rhizocarpon bolanderi* (Tuck.) Herre based on the general aspect of its areolate thallus and its lecideine apothecia.

In its nomenclatural history, the taxon has been placed in six genera and has been described twice.

The taxon was first described by Tuckerman (1866) from a Bolander collection from sandstone rocks on the coast of California. Tuckerman (1888) later reported it from the Dallas of the Columbia in Oregon from a Hall collection made in 1871. We examined the Hall specimen (FH!) and found it does not contain miriquidic acid. Although it looks very similar to *M. scotopholis* it is probably a member of the *Lecidea atrobrunnea* group. Timdal (1984) published TLC data for the holotype, reporting miriquidic acid and four accessory unknowns. The holotype was at ASU during the Sonoran lichen flora project. Bruce Ryan prepared a modern description (Nash et al. 2004a). It was apparently lost in the mail when the loan was returned to FH after Ryan's death. Thankfully, an isotype is among the material retained at Amherst College after the transfer of Tuckerman's herbarium to Harvard University. The specimen was subsequently donated to NY in 1989 and is here selected as the lectotype.

Based probably on its lecideine apothecia, Herre (1910) transferred *M. scotopholis* to *Lecidea.* He reported it from Mt. San Bruno on sandstone at 1000 ft, and on the Santa Cruz Peninsula to 1800 ft. Hasse (1913) reported the species from Yosemite Valley and Catalina Island as common in higher ranges of cismontane California. The specimens documenting these reports need to re-examined. Fink (1935), based on its sub-squamulose thallus, transferred the species to *Psora.* Schneider (1980) transferred the species to *Psorula* but it differs from the other member of the genus, *P. rufonigra* (Tuck.) Gotth. Schneid., in "having filiform conidia, a different ascus type, brown epihymenium, loose paraphyses, pale hypothecium, and different chemistry" (Nash et al. 2004a). Timdal (1984) recognized these differences, but because the ascus type of *M. scotopholis* is intermediate between a *Bacidia*-type and a *Lecanora*-type, he placed it in *Lecanora*. Eventually Ryan & Timdal (Nash et al. 2004a) transferred it in to the genus *Miriquidica*. They saw no specimens other than the type during the Sonoran Flora project and reported it as "expected but not confirmed from south of coastal, central California".

Based on collections from Baja California, where the taxon is common, Rambold et al. (1996) described *Miriquidica mexicana*; they were unfamiliar with *M. scotopholis*, which at that time was included in *Lecanora.* Bjorn Owe-Larsson, while traveling with the second author (KK) in 2004 pointed out the species as *M. mexicana* in the San Jacinto and Santa Monica Mountains.

They reported it as new to California (Knudsen & Owe-Larsson 2005). They recognized there were serious problems keying out specimens as either *M. mexicana* or *M. scotopholis* using the key for the genus in Nash et al. (2004a). After numerous collections, and waiting for the holotype to hopefully be found, we re-examined the problem. We found *M. mexicana* does not differ from other specimens in California referable to *M. scotopholis*. The two descriptions in Nash et al. (2004a) erect a false division in the range of variability in epihymenial color, spore width, thallus color, whether or not erumpent apothecia have an evanescent thalline margin, and color of apothecial margin. *Miriquidica mexicana* is proposed here as synonymous with *M. scotopholis.* In the protologue of *M. mexicana* (Rambold et al. 1996) the chemistry is listed as miriquidic acid or lobaric acid. Specimens with lobaric acid have since been described as the new species *Protoparmelia ryaniana* van den Boom, et al. (van den Boom et al. 2007). That species has maritime distribution, is a juvenile parasite, and is known from North Baja California in Mexico, and Point Loma (*Knudsen 8242*, UCR) and Catalina Island in California. Further, chemical analysis of the type of *M. mexicana* revealed that it contains several unknowns in addition to miriquidic acid, and is chemically identical to the lectotype (and all other specimens of this taxon) we have examined.

A new description is supplied due to the confusion in Nash et al. (2004a) and the segregation of *Protoparmelia ryaniana* (van den Boom et al. 2007). The protologue for *M. mexicana* is detailed and can be referred to for more information (Rambold et al. 1996).

DESCRIPTION. Thallus crustose, epilithic, contiguous to dispersed, areolate, up to 1 mm thick, often covering areas up to 5 cm or more, confluent with other thalli. Usually it is surrounded by a distinct black dendroid-branched prothallus. Areoles 0.10-1.5 mm diam, becoming convex, or twisted, angular to round, the rim often upturned, undulate or crenulate, prominent and black, sometimes white pruinose. The attachment can elongate and areoles become thicker and imbricate, and appear squamulose. The surface of areoles is reddish-brown to almost black, rarely a yellowish-brown, usually shiny. Upper cortex is up to 50 µm thick, the upper layer brown-pigmented with an epinecral layer, the lower layer hyaline. The lower surface is corticate, black-brown. The attachment is broad, over one-half of the diameter of areoles. The alga layer is thin, uneven, interrupted. Photobiont is chlorococcoid green algal, 7-12 µm diam. Medulla, white, thick, I-, prosoplectenchymatous. The apothecia are erumpent, 0.3-1 mm in diam., becoming sessile, lecideine, rarely with thalline margin which does not persist, but with scattered algal cells in the exciple. The disc is black, plane to convex, reddish-brown when wet, epruinose, with prominent black to grayish margin, sometimes white pruinose. The exciple is up to 90 µm wide, outer layers shades of olive and brown becoming hyaline within, inspersed with crystals of miriquidic acid (Rambold et al. 1996) and scattered algal cells. Hymenium is up to 50 µm tall, I- or I+ blue, hyaline below, greenish to brown in upper part including epihymenium; epihymenium 7-12 µm tall; paraphyses 1.5-2.5 µm wide at mid-level, rarely branched or anastomosing, apices expanded to 4-5 µm, sometimes with brown pigment. The hypothecium is up to 100+ µm thick with crystals of lichen substances in lower area (Rambold et al. 1996). Asci 30-45 x 7-14 µm wide. The outer wall of ascus is I+ blue. "Tholus max. 7-8 µm, min.5-6 µm high, without or with small ocular chamber, with narrow axial body" (Rambold et al. 1996) with an almost *Lecanora*-type stain. Ascospores hyaline, simple, ellipsoid, 6-11 x 3-5 µm wide. Condiomata pycnidial, black, immersed, mostly 0.1 mm, usually near edges of areoles. Conidiophores "similar to type V of Vobis [1980]" (Rambold et al. 1996). Conidia long filiform 20-40 x 0.7-1 µm.

CHEMISTRY. miriquidic acid and four or five unknowns.

DISTRIBUTION. Washington to Baja California (Rambold et al. 1996, Nash et al. 2004a), on acid rock, from 13-1602 m, associated with Coastal Sage Scrub, *Adenostoma fasciculatum* or *A. sparsifolium* chaparral, mesic mixed chaparral, oak woodland, pinyon pine woodland, or conifer or mixed oak-conifer forest. It occurs usually in mixed saxicolous lichen associations often with *Aspicilia* species. In a recent study of San Jacinto Mountains, mostly above 2000 meters, no *M. scotopholis* was found though it is abundant below 1600 meters (Knudsen & Kramer 2007). Thomson (1997) reported it as far north as Saskatchewan in Canada but we saw no vouchers from that study.

ILLUSTRATIONS. Rambold et al. (1996), p. 321; Nash et al. (2004b).

DISCUSSION. The thallus is often sterile and appears blackish and undistinguished in the field and is easily ignored. The prothallus is distinctive but not always evident. In southern California and Baja it is usually locally abundant on hard or decaying outcrops, rocks, and even on pebbles of basalt, volcanic rock, granite, and sandstone. The species is easily separated from the *Lecidea atrobrunnea* group by ascus stain and chemistry because none of the *Lecidea* species contain miriquidic acid. *Protoparmelia ryaniana* has lobaric acid, narrower spores (2.5-3 µm), shorter filiform conidia (15-16 µm long) and a strictly maritime distribution. *Rhizocarpon bolanderi* has large three-septate to murifom spores, two per ascus. In the range of *M. scotopholis* in central and southern California we collected no other *Miriquidica* species, although *M. garovaglii* is similar to *M. scotopholis* it differs in having stictic acid in its medulla and larger ascospores; and has been collected on San Clemente Island in Los Angeles County, California, by Charis Bratt, the specimen determined by Alan Fryday (Shirley Tucker, pers. comm.)

Selected Specimens Studied – **U.S.A. CALIFORNIA. HUMBOLDT CO.:** Bald Mountain, 18 km E of Arcata, on open rocky ridge top, 40°52'N 123°52'W, 920 m., on rock, iii.2001, *B. McCune et al. 25825* (hb. McCune). **ORANGE CO.:** Santa Ana Mountains, Weir Canyon, along Windy Ridge Road 33°50'11"N 117°43'43"W, 280 m., on sandstone, 19.v.2006, *K. Knudsen 6181.3* (UCR); Santa Ana Mountains, Santiago Peak below transmitter tower, 33°42'52"N 117°32'03"W, 1633 m., on boulders and rock outcrops, 22.vi.2004, *J.C. Lendemer 2848 & K. Knudsen* (hb. Lendemer). **RIVERSIDE CO.:** Menifee Hills, Bundy Canyon, 33°37'32"N 117°14'23"W, 487 m., on rock, 23.vi.2004, *J.C. Lendemer 4185 & K. Knudsen* (hb. Lendemer); Santa Ana Mountains, Elsinore Peak, 33°35'32"N 117°21'01"W, 926 m., on volcanic rock in chaparral, 25.xi.2005, *K. Knudsen 4376* (UCR); San Jacinto Mountains, Idyllwild, near Inspiration Point, 33°43'36"N 116°45'03"W, 1602 m., on granite boulders in full sun in *Pinus jefferyii* forest, 4.viii.2005, *K. Knudsen 3439* (UCR). **SAN BENITO CO.:** Pinnacles National Monument, along Chalone Creek, 36°29'05"N 121°10'03"W, 321 m., on volcanic rock in riparian woodland, *K. Knudsen 4146 & B. Hill* (SBBG, UCR). **SAN BERNARDINO CO.:** Joshua Tree National Park, Key's Ranch, 34°02'83"N 116°09'64"W, 1268 m., on granite, *K. Knudsen 3037 & T. la Doux* (UCR); Granite Mountains, Sweeney Granite Mountain UC Reserve, canyon above Yucca Bajada Camp, 34°48'52"N 116°38'37"W, 1237 m., on granite, 12.xii.2006, *K. Knudsen 7991.1 & R. Muertter* (UCR). **SAN DIEGO CO.:** Cuyamaca Mountains, Cuyamaca State Park, above Sweetwater River, 32° 54' 41"N, 116° 34' 30"W, 1222 m, on granite, 10.x.2007, *K. Knudsen 9125* (SD); Palomar Mountain, Palomar State Park, below Nate Harrison Grade, along Adams Trail, 33°20'41"N 116°55'14"W, 1475 m., on hard granite in shade of oak-conifer woodland, 13.v.2005, *K. Knudsen 2934.1 & M. Knudsen* (UCR). **SAN LUIS OBISPO CO.:** San Simeon, San Simeon State Park, coast southeast of state park headquarters on bluff above shore, 33°38'25"N 121°08'28"W, 18 m., on volcanic rock in costal sage scrub, 10.i.2007, *K. Knudsen 8207* (FH, PRM 857299, hb. Lendemer). **WASHINGTON. KITTITAS CO.:** by Columbia River, 8 km S of I-90 bridge, 50 km ESE of Ellensberg, 47°120°N, 185 m., viii.1987, *B. McCune 17059* (hb. McCune).

7. *Phaeographis asteroides* (Fink) Lendemer, **comb. nov.**

MycoBank MB 511164.

Phaeographina asteroides Fink, Mycologia, 19: 219. 1927. TYPE: Porto Rico, in an open field near Mayaguez, *B.E. Fink 981* (MICH, holotype; NY!, isotype).

Phaeographis asteroides was described by Fink (1927) from Puerto Rico and subsequently reported from North America by Harris (1990). The white margins of the lirellae, which are immersed and initially hide the disc, are rather distinctive and make this taxon fairly easy to recognize in the field. Unfortunately the type collection is in poor condition, likely due to the age of the thallus, and the margins of the lirellae have been distinctly abraded or eroded. All of the North American collections of this species are from Florida. Continued field work in the southeastern United States will likely reveal it to be more widespread. In addition to the distinctive white margined lirellae, the species can be recognized by the fully carbonized exciple, hymenium that is not inspersed, brown submuriform ascospores (8/ascus, 28-35 x 10-15µm, 6-8 x (1)-2-4 celled), and lack of lichen substances.

8. ***Phaeographis atromaculata*** (A.W. Archer) A.W. Archer, Telopea, 11: 75. 2005.

Syn. *Phaeographis kalbii* Staiger, Biblio. Lich., 85: 332. 2002.

Syn. nov. *Phaeographis illitoraticola* Lendemer, R.C. Harris & Yahr, nom. nud., Evansia, 21(3): 128. 2004.

When the first author (JCL) and his colleagues first encountered this species in coastal North Carolina, USA they assigned it a tentative name since they presumed it was an undescribed species (Lendemer & Yahr 2004) related to the then recently described *Phaeographis kalbii* which differed in having two-spored asci according to Staiger (2002). While those authors were preparing a description of the North American material, Archer (2006) placed *P. kalbii* in synonymy with *P. atromaculata* noting the asci to be monosporous in Australian material. Since the North American material shared this character it was clear further study was needed. After comparison of the North American material with the illustrations provided by Archer (2006) and Staiger (2002), as well as photographs of typical South American material kindly provided by Robert Lücking, it was clear that the North American populations belonged to *P. atromaculata*. Following Archer (2006) *P. atromaculata* has a pan-tropical distribution, and the occurrence of such a widely distributed taxon is not unexpected in the southeastern United States. The species is easily recognized by its circular to somewhat elongate apothecia, often with ragged thalline margins, asci containing a single large brown densely muriform ascospore, and the presence of norstictic acid in the thallus. The present collections indicate the species to be restricted to maritime habitats in North America, but further collecting my reveal it to have a wider habitat distribution in the more tropical parts of the southeastern United States. These are the first reports of *P. atromaculata* from North America.

Specimens Examined. – **U.S.A. NORTH CAROLINA. BRUNSWICK CO.:** Bald Head Island, 5.vii.2003, *J.C. Lendemer 1622 & R. Yahr* (hb. Lendemer), *R. Yahr 4848* (DUKE), *R. Yahr 4855* (DUKE). **CARERET CO.:** Cape Lookout National Seashore Shackleford Banks, 19.iii.2003, *J.C. Lendemer et al. 738* (hb. Lendemer); Theodore Roosevelt Natural Area, 20.iii.2003, *J.C. Lendemer et al. 706* (hb. Lendemer), *R. Yahr 4691* (DUKE), *R. Yahr 4734* (DUKE).

9. ***Platythecium floridanum*** (Tuck.) Lendemer, **comb. nov.**

MycoBank MB 511043.

Graphis floridana Tuck., Syn. N. Amer. Lich., 2: 126. 1888. TYPE: U.S.A., East Florida, 1877, *J. Donnell Smith s.n.* (FH-TUCK! [ex herb. C.F. Austin], lectotype selected here; NY!, isolectotype).

Graphina floridana (Tuck.) R.C. Harris, Some Florida Lichens, p. 14. 1990.

At the time of its description, Tuckerman (1888) considered *Graphis floridana*, to be closely related to related to *Graphis grammitis* Fée (= *Platythecium grammitis* (Fée) Staiger). Because of its submuriform ascospores Harris (1990) transferred the species to *Graphina* Müll. Arg. Following the current generic concepts proposed by Staiger (2002) this taxon should be placed in *Platythecium* Staiger, and the new combination is made here. *Platythecium floridanum* is a distinctive species because of its long branching lirellae that lack carbonization, the presence of abundant norstictic acid in the thallus, and hyaline submuriform ascospores (15-20 x 7-9μm, 8/ ascus).

10. ***Thalloloma hypoleptum*** (Nyl.) Staiger, Bib. Lich., 85: 437. 2002.

Graphis hypolepta Nyl., Acta Soc. Sci. Bot. Fenn., 7: 472. 1863.

Syn. nov. *Graphis anguinoides* R.C. Harris nom. nud., More Florida Lichens, p. 12. 1995.

Harris (1995) published *Graphis anguinoides* as a nomen nudum. When Staiger (2002) revised the generic concepts in the *Graphidaceae* she transferred the related species *G. anguina* (Mont.) Nyl., to *Thalloloma* Trevis. While the first author (JCL) was working on this paper Richard Harris suggested the material he referred to *G. anguinoides* might be conspecific with *T. hypoleptum*, a species that is widely distributed in tropical Central/South America (Staiger 2002). Examination of the material in light of Staiger's treatment confirms this, and *T. hypoleptum* should be added to the North American checklist. The species is common on *Ilex, Magnolia,* and *Taxodium* in subtropical portions of the southeastern United States, and although the specimens reported here are from Florida, the species will likely be found elsewhere in the region as further collections accumulate. *Thalloloma hypoleptum* can be recognized by the creamy white thallus with inconspicuous brownish lirellae lacking any carbonization. The ascospores are eight to the ascus, hyaline, and transversely septate (20-30 x 6-9μm), with (5)-8-10 cells. The thallus in all of the North American material examined to for this paper was UV+ yellow due to the presence of lichexanthone, however a chemotype lacking lichexanthone was reported by Staiger (2002).

Specimens Examined. – **U.S.A. FLORIDA. BAKER CO.:** Along C.R. 127, 26.xi.1996, *R.C. Harris 39298* (NY). **BAY CO.:** N of Co. Rd. 388, 1.xii.1994, *R.C. Harris 35768* (NY). **COLLIER CO.:** Big Cypress National Preserve, 9.xii.1992, *R.C. Harris 30179* (NY). **COLUMBIA CO.:** Osceola National Forest, 2.i.1991, *W.R. Buck 19077* (NY). **ESCAMBIA CO.:** Along Pineville Road ca. 2 mi W of Co. Rd. 97A, 8.xii.1993, *R.C. Harris 31950* (NY). **FLAGLER CO.:** Along Co. Rd. 304 at Sweetwater Creek, 6.i.1996, *R.C. Harris 37407* (NY). **JEFFERSON CO.:** E of St. Rd. 59, 12.xii.1993, *R.C. Harris 32323* (NY). **LAFAYETTE CO.:** Just W of Fla. Hwy. 51, 29.xi.1994, *R.C. Harris 35548* (NY). **LEVY CO.:** Black Point Swamp, 30.xi.1992, *R.C. Harris 29390* (NY). **LIBERTY CO.:** 21.5 mi E of Wilma, 28.xii.1990, *R.C. Harris 26111* (NY). **WAKULLA CO.:** Apalachicola National Forest, 1.i.1991, *R.C. Harris 26209* (NY). **SUMTER CO.:** Withlacoochee State Park, 5.xii.1996, *R.C. Harris 39843-A* (NY).

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Literature cited

Archer AW. 2006. The lichen family *Graphidaceae* in Australia. Bibliotheca Lichenologica, 94: 1-191.

Beeching SQ. 2007. *Dimelaena tenuis* (lichenized *Ascomycota*) new to North America, and *Xanthoparmelia pseudocongensis* new to Georgia, USA. Opuscula Philolichenum, 4: 55-56.

Brodo IM, Duran Sharnoff S, Sharnoff, S. 2001. Lichens of North America. Yale University Press, New Haven & London. 795 pp.

Ekman S. 2001. Molecular phylogeny of the *Bacidiaceae* (*Lecanorales,* lichenized *Ascomycota*). Mycological Research, 105(7): 783-797.

Ekman S, Tønsberg T. 1996. A new species of *Megalaria* from the North American west coast, and notes on the generic circumscription. The Bryologist, 99(1): 34-40.

Etayo J. 2002. Aportación al Conocimiento de los Hongos Liquenícolas de Colombia. Bibliotheca Lichenologica, 84, J. Cramer, Berlin, Stuttgart. 154 pp.

Fink B. 1927. New species of lichens from Porto Rico-I. *Graphidaceae*. Mycologia, 19: 206-221.

Fink B. 1935. The Lichen Flora of the United States. Completed for Publication by Joyce Hedrick. University of Michigan Press\Ann Arbor. xii + 426 pp.

Fryday AM. 2004. A new species of *Fuscopannaria* with a green photobiont, and other taxonomic innovations and new records of lichenized-fungi from Alaska. The Bryologist, 107(2): 173-179.

Fryday AM. 2007. A new species of *Megalaria* from Iles Kerguelen in the southern Indian Ocean. The Lichenologist, 39(4): 371-376.

Harris RC. 1990. Some Florida Lichens. Publ. by the Author, Bronx, N.Y. 109 pp.

Harris RC. 1995. More Florida Lichens. Including the 10¢ Tour of the Pyrenolichens. Publ. by the Author, Bronx, N.Y. 192 pp.

Hasse HE. 1913. The lichen flora of southern California. Contributions from the United States National Herbarium 17: 1-132.

Hedrick J. 1933. New genera and species of lichens from the Herbarium of Bruce Fink. I. Mycologia, 25: 303-316.

Herre AWCT. 1910: The lichen flora of the Santa Cruz Peninsula, California. Proceedings of the Washington Academy of Sciences 12: 27-269.

Jagadeesh TAM, Aptroot A, Sinha GP, Singh KP. 2007. A new isidiata *Megalaria* species and new records of lichenized, Lichenicolous and non-lichenized ascomycetes from India. Nova Hedwigia, 85: 139-144.

Kalb K. 2007. New or otherwise interesting Lichens. III. Lichenological Contributions in Honour of David Galloway. I Kärnefelt and A Thell (eds.) Bibliotheca Lichenologica: 95: 297-316.

Knudsen K, Owe-Larsson B. 2005. *Miriquidica mexicana* in Southern California. Bulletin of the California Lichen Society, 12(1): 7-8.

Knudsen K, Kramer K. 2007. The Lichen Flora of the San Jacinto Mountains: San Jacinto Wilderness Area, Riverside, California, USA. Evansia, 24 (2): 42-47.

Lendemer JC. 2006. Contributions to the lichen flora of New Jersey: a preliminary checklist of the lichens of Wharton State Forest. Opuscula Philolichenum, 3: 21-40.

Lendemer JC. 2007. *Megalaria beechingii* (lichenized *Ascomycota*), a new species from Eastern North America. Opuscula Philolichenum, 4: 39-44.

Lendemer JC, Yahr R. 2004. A checklist of the lichens collected during the Tuckerman Workshop #12, Outer Banks, North Carolina, USA. Evansia, 21(3): 118-136.

Nash III TH, Kainz C, Zedd L, Ryan BD., Rambold G. 2004a. *Miriquidica In:* Nash III TH, Ryan BD, Diederich P, Gries C, Bungartz F (eds.) Lichen Flora of the Greater Sonoran Desert Region, Vol. 2. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 361-363

Nash III TH, Ryan BD, Diederich P, Gries C, Bungartz F (eds.) 2004b. Lichen Flora of the Greater Sonoran Desert Region. Lichens Unlimited, Arizona State University, Tempe, Arizona. 742 pp.

Rambold G, Sipman H, Hertel H. 1996. A new species of *Miriquidica* from the coastal desert in Baja California. Mycotaxon 58:319-324.

Thomson JW. 1997: American Arctic Lichens. 2. The Microlichens. The University of Wisconsin Press, Madison. 675 pp.

Schneider, G. 1980 "1979". Die Flechtengattung *Psora* sensu Zahlbruckner. Bibliotheca Lichenologica, No. 13. J. Cramer, Vaduz. 291 pp.

Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*. Studien in Richtung einer natürlicheren Gliederung. Bibliotheca Lichenologica, 85. J. Cramer, Berlin, Stuttgart. 526 pages.

Timdal E. 1984. The delimitation of *Psora* (*Lecideaceae*) and related genera, with notes on some species. Nordic Journal of Botany 4: 525-540.

Tuckerman E. 1866. Lichenes of California, Oregon and the Rocky Mountains; so far as yet known. With an appendix. J.S. & C. Adams, Amherst. 35 pp.

Tuckerman E. 1888. A synopsis of the North American lichens. Part. II. Comprising the Lecideacei, and (in part) the *Graphidacei*. New Bedford, Mass. 176 pp.

Van den Boom P, Sipman H, Elix JA. 2007 in press. *Protoparmelia In*: Nash III TH, Ryan BD, Diederich P, Gries C, Bungartz F (eds.) 2007. Lichen Flora of the Greater Sonoran Region, Vol. 3. Lichens Unlimited, Arizona State University, Tempe, Arizona.

Vobis G. 1980. Bau und Entwicklung der Flechten-Pycnidien und ihrer Conidien. Bibliotheca Lichenologica No. 14. J. Cramer, Vaduz. 141 pp.

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Ascomycetes of Sonora, Mexico. 1: The Ajos-Bavispe National Forest Reserve and Wildlife Refuge

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Abstract — Eight species of *Ascomycetes* from the Ajos-Bavispe National Forest Reserve and Wildlife Refuge, located in Sonora, Mexico are recorded for the first time in the Mexican mycobiota: *Cenangium yuccae*, *Diatrype standleyi*, *Eutypa koschkelovae*, *E. podanthi*, *Gloniopsis praelonga*, *Hypocrea scutelliformis*, *Hysterium insidens*, and *H. truncatulum*. Photomicrographs, descriptions, and some ecological observations are presented.

Key words — *Helotiales, Hypocreales, Xylariales, Hysteriales*

Introduction

The Ajos-Bavispe National Forest Reserve and Wildlife Refuge (ABNFR) is located in the northeastern part of the state of Sonora in Mexico, and has five mountain ranges. The vegetation is mainly pine forest, pine-oak forest, oak forest, gallery forest, and microphyllous desert scrub. The biological diversity catalogued for the ABNFR includes a little over 1,230 vascular plant species, along with 358 vertebrates and 92 diurnal butterflies (Guerra 1998).

There are some contributions to the taxonomy of *Ascomycetes* from Sonora (Esqueda et al. 1992, Pérez-Silva et al. 1996, San Martín et al. 1999a,b,c), but only three from ABNFR for *Aphyllophorales* (Montaño et al. 2006) and *Myxomycetes* (Moreno et al. 2006, Lizárraga et al. 2007). Therefore, these are the first records of *Ascomycetes* from ABNFR and are new to the Mexican mycobiota.

The collections studied were obtained from seven types of vegetation in the ABNFR that were sampled seasonally from fall 2004 to summer 2005: pine-

Table 1. Sampling sites on the Ajos-Bavispe National Forest Reserve and Wildlife Refuge.

Site	N	W	Altitude	Vegetation
Municipality of Cananea				
1. El Campamento	30°58´22"	109°57´38”	1997 m	POF-GF
Municipality of Fronteras				
2. El Frijolito	30°56´35”	109°57´21”	2286 m	POF
3. La Valdeza	30°38´06”	109°47´22”	1546 m	OOF
Municipality of Cumpas				
4. Km 8 Moctezuma to La Antena road	29°58´53”	109°39´52”	818 m	MDS
5. La Antena	30°00´02”	109°33´29”	1653 m	PF
6. La Selva	29°57´41”	109°36´55”	881 m	SS
7. El Mezquital	29°57´26”	109°38´23”	882 m	M

Vegetation types: pine-oak forest associated with gallery forest (POF-GF); pine forest (PF); pine-oak forest (POF); oak open forest (OOF); microphyllous desert scrub (MDS); mesquite (M); subtropical scrub (SS).

oak forest associated with gallery forest, pine forest, pine-oak forest, oak open forest, microphyllous desert scrub, mesquite, and subtropical scrub. The seven sites were geo-referenced with a GPS Garmin 12XL, using Datum NAD-27 for digital image processing.

The specimens were collected and conserved following the recommended mycological techniques for *Ascomycetes* (Dennis 1978, Breitenbach & Kranzlin 1981). Species identification was based on Ellis & Everhart (1892), Seaver (1978), Dennis (1978), and Sivanesan (1984); and specific literature as Rappaz (1987), Barr (1990), and Chacón (2004, 2005). The specimens have been deposited in the macromycetes collection of the Centro de Estudios Superiores del Estado de Sonora (CESUES), with some duplicates in the Herbarium of the Instituto de Ecología, A.C. (XAL) in Xalapa, Veracruz.

Species List

Cenangium yuccae Clem. & E.G. Clem. ex Seaver, N. Amer. Cup-fungi. Inoperc.: 303. 1951

Apothecia 0.8 to 2 mm, erumpent, hysterothecioid at first with involute margins; when mature open and cup-shaped; hymenium yellowish when fresh to light brown when dry, with a darker brown exterior; sessile appearance but fixed to substrate by a short stalk, robust. Asci 90-115 × 7-11 µm, cylindrical, octosporate, base ending in a short stipe, apical pore amyloid. Ascospores 9-12 × 6-8 µm, ellipsoid, thin-walled, uniseriate in the ascus. Paraphyses 3-5 µm in diam., filiform, hyaline and septate.

SPECIMENS STUDIED: LOCALITY 2, leg. F. Méndez & S. Gómez, 23.VIII.2005, on dry *Yucca* sp. leaf, in ecotone with pine-oak forest, *CESUES 5994, Chacón-5575 (XAL).*

OBSERVATIONS The Mexican collection studied is consistent with *C. yuccae* as described by Seaver (1978) based on specimens from Colorado and California in the U.S.A. This author described the species as having slightly smaller apothecia (1 mm), and paraphyses (2 µm in diam.). Worldwide, this taxon has been recorded on rare occasions, and this is the first record in the Mexican mycobiota.

Hypocrea scutelliformis Berk. & Ravenel, in Ellis & Everhart,
N. Amer. Pyrenomyc.: 80. 1892

Stromata 3 mm in diam., discoidal with some dents in center, apparently sessile but short-stalked, robust, dark with brown-reddish powder. Surface dotted with perithecia ostioles; context whitish to light brown. Perithecia 100-150 × 6-120 µm, globose to subglobose, arranged in one layer (monostichous), on rare occasions polystichous; neck very short. Asci 60-80 × 4-6 µm, cylindrical-clavate, inamyloid. Ascospores 2-4 × 2.5-4.5 µm, globose to subellipsoidal, some narrower at one end, wall minutely warted, hyaline with greenish tones, octosporate at first, ending with 16 part-spores, each with an oil droplet at the center.

SPECIMENS STUDIED: LOCALITY 7, *leg.* A. Sánchez, 24.II.2005, solitary, on fallen branches in mesquite vegetation, *CESUES 5994.*

OBSERVATIONS: The Mexican collection agrees well with the description of *H. scutelliformis* given by Seaver (1910) and Ellis & Everhart (1892). Among its distinguishing characteristics are discoidal stromata and asci octosporate at first, but ending in 16 part-spores. Including this record, three species of *Hypocrea* are known for Mexico; the others are *H. citrina* var. *americana* Canham, cited for Morelos and Hidalgo (Chacón & Guzmán 1983) and *H. rufa* (Pers.: Fr.) Fr., recorded for Veracruz (Welden & Guzmán 1979).

Diatrype standleyi Fairm., Mycologia 10: 240. 1918

Stromata (1.5-) 2-2.5 mm in diam., erumpent, partially covered with remnants of host bark, dark, sometimes with slight purplish-reddish tones; surface dotted with perithecia ostioles; context brown to light brown. Perithecia (including neck) 550-620 × 190-290 µm, globose to piriform, mono- or polystichous. Ostioles with 3-4 apical openings radially arranged. Asci 60-100 ×

7-10 µm, cylindrical-clavate, base ending in a thin stipe, apical pore inamyloid. Ascopores 10-13 × 3-4 µm, alantoid, pale yellowish to brownish-red in mass, irregularly biseriate in ascus.

> SPECIMENS STUDIED: LOCALITY 1, *leg.* F. Méndez & S. Gómez, 21.I.2005. On fallen *Quercus* sp. leaves in pine-oak forest associated with gallery forest, *CESUES* 5400. *Ibidem,* 24.VIII.2005, *CESUES 5841, Chacón-5613 (XAL).*

OBSERVATIONS: The Mexican material fits with *D. standleyi*, as described by Rappaz (1987) based on specimens from New Mexico, U.S.A. Similar species include *D. praeandina* (Speg.) Rappaz, recorded for Argentina, but the latter has larger stromata (3-20 × 1-2 mm), while its asci (40-50 × 5-6 µm), ascospores (9-12 × 2.2-2.8 µm), and perithecia (200-400 µm) are smaller.

Eutypa koschkelovae Frolov, Nov. Sist. niz. Rast. 7: 194. 1970

Stromata irregular, spread out, 1-10.5 × 1-2.5 mm, occasionally linear, appearance superficial to erumpent, dark, partially covered by bark remnants; context light yellowish-brown; surface dotted with perithecia ostioles. Perithecia 230-440 × 160-340 µm, globose to subglobose. Ostioles 180-295 × 90-160 µm, prominent, with 3-4 radially arranged, linear openings at the apex. Asci (32-) 35-45 × 5-9 µm, cylindrical-clavate, base ending in a long, thin stipe, apical pore inamyloid. Ascospores 6.5-10 × 1.5-2.5 µm, allantoid, hyaline to pale yellowish, ochraceous color in mass.

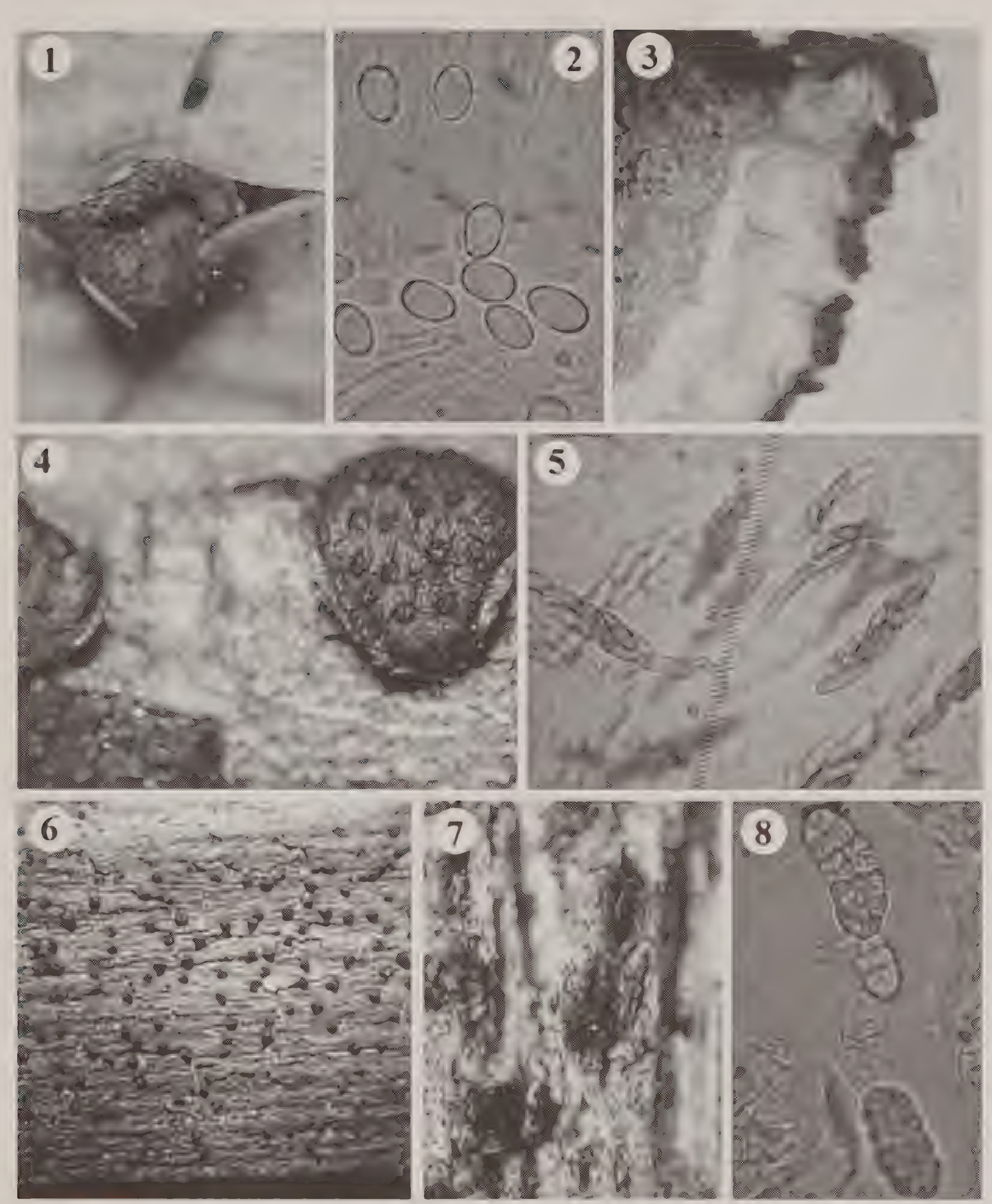
> SPECIMENS STUDIED: LOCALITY 4, *leg.* F. Méndez & S. Gómez, 25.VIII.2005, on bark and fallen trees in microphyllous desert scrub, *CESUES 6167, Chacón-6631 (XAL).*

OBSERVATIONS: All macro- and microscopic characteristics fit with E. koschkelovae, as cited by Rappaz (1987) based on a Russian collection from *Calligonum* sp. (*Polygonaceae*). The host was not identified in the Sonoran collection. According to this author, the species was previously only known from its type locality (Russia). This is the second documentation of this species for the rest of the world and the first for the Americas.

Eutypa podanthi Speg., Bol. Acad. Nac. Ci. Cordoba 25: 47. 1921

Stromata one to several cm long, flat, spread out, dark gray with blackish dots from the perithecia ostioles; context minute or absent. Perithecia 440-500 × 430-500 µm, globose, embedded in wood. Ostioles 200-450 × 210-260 µm, having 3-4 apical openings radially arranged. Asci 50-65 × 6-8 µm, cylindrical-clavate, base ending in a thin stalk, apical pore inamyloid. Ascospores 9-12(-14) × (2.8-)3(-3.5) µm, alantoid, yellowish to brown in mass, irregularly biseriate in the ascus.

> SPECIMENS STUDIED: LOCALITY 7, *leg.* F. Méndez & S. Gómez, 27.VIII.2005, on dead *Prosopis velutina* wood in mesquite vegetation, *CESUES 6352, Chacón-5673, 5676 (XAL).*



Figs. 1-8. Ascomycetes of Sonora, Mexico. 1-2: *Cenangium yuccae*, 1: apothecium, 2: ascospores. 3: *Hypocrea scutellaeformis*, longitudinal section of the stroma showing perithecia. 4-5: *Diatrype standleyi*, 4: stroma, 5: asci and ascospores. 6: *Eutypa podanthi*, stromatic surface showing ostioles. 7-8: *Gloniopsis praelonga*, 7: hysterothecia, 8: ascospores.

Observations: The Mexican collection agrees with *E. podanthi*, as described by Rappaz (1987) based on material collected by Spegazzini in Chile on *Podanthus mitiqui*, but the host was different, and the spore size was smaller (9-13.8 × 2.2-2.5 µm) in the Chilean material. The Spegazzini collection dates from 1918 and, according to Dr. C. Carmaran (Researcher at the University of Buenos Aires, Argentina, pers. com.) the Chilean material only has two perithecia that are in very poor condition. This opens the possibility for the Mexican material to be proposed here as the epitype. This species, together with *E. koschkelovae*, was only known for the type locality.

Gloniopsis praelonga (Schwein.) Underw. & Earle, Bull. Alabama Agric. Exp. Sta. 80: 196. 1897

Hysterothecia 0.8-1.2 × 0.4-0.7 mm, erumpent to superficial, ellipsoid to fusoid tips, open or partially closed in dehydrated specimens; exterior dark, hymenium same color or lighter. Smooth margin or with fine longitudinal sulcations. Asci 65 × 12 µm, cylindrical-clavate, short-stipitate, apical pore inamyloid. Ascospores 16-29 × 8-13 µm, muriform, hyaline to pale yellow, elliptical to ovoid with obtuse tips.

SPECIMENS STUDIED: LOCALITY 5, *leg.* F. Méndez & S. Gómez, 26.VIII.2005, solitary to gregarious, on bark of fallen trees in pine-oak forest, *CESUES 6239*, *Chacón-6658 (XAL)*.

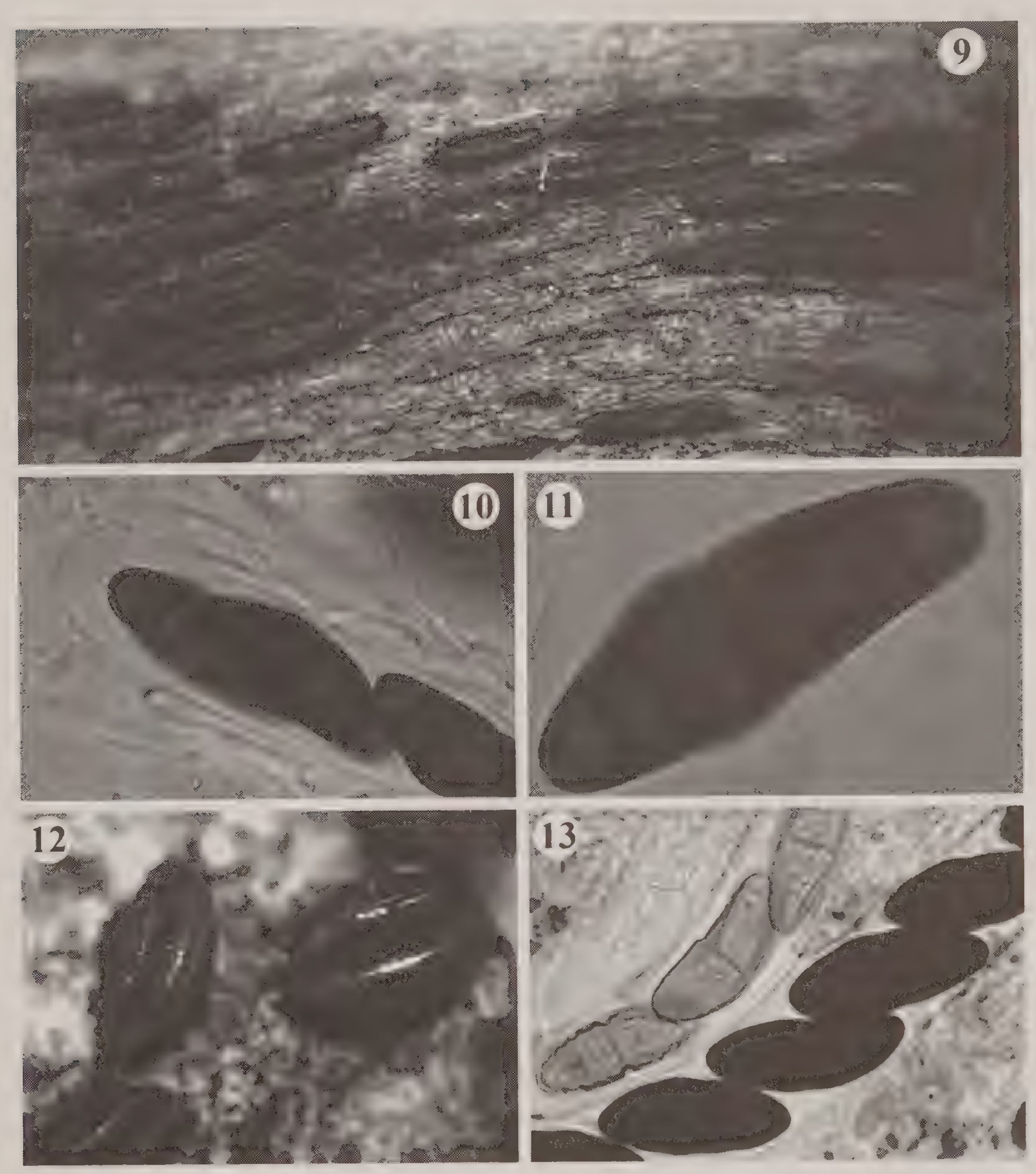
OBSERVATIONS: The Sonoran collection fits with *G. praelonga*, as described by Barr (1990) based on specimens from Italy and the United States of America, but ascus size was larger (60-120 × 15-25 µm) in those countries. Barr (1990) recorded high morphological variability for the macro- and microscopic characters of this species, resulting in the same species having been cited several times as a new species and thus increasing its list of synonyms. Kirk et al. (2001) recognized two species for the genus: *G. praelonga* and *G. smilacis* (Schwein. : Fr.) Underw. & Earle; both taxa were studied by Barr (1990).

Hysterium insidens Schwein., Trans. Amer. Phil. Soc., N.S. 4(2): 244. 1832

Hysterothecia 0.7-4.8 mm long, subellipsoidal with tapered bases, linear and nearly parallel, erumpent to superficial; central part with straight longitudinal opening, dark with opaque to bright tones, external surface smooth, carbon-like appearance. Asci 155-195 × 18-22 µm, cylindrical-clavate, bitunicate, base ending in a short stipe, apical pore inamyloid. Ascospores 32-45 × 11-14 µm, elliptical to subfusoid, brown-olive tone, with 6-8 septi, central part of apical region a little wider than the rest, irregularly biseriate in ascus.

SPECIMENS STUDIED: LOCALITY 3, *leg.* F. Méndez & S. Gómez, 25.VIII.2005, solitary or gregarious, on the bark of branches and fallen trunks in oak forest clearings, *CESUES 5965*, *Chacón-6627(XAL)*.

OBSERVATIONS: The Mexican collection fits with descriptions of Ellis & Everhart (1892), Dennis (1978), and Sivanesan (1984), who analyzed specimens from Africa, North America, and Europe, but ascus size was different. Ellis & Everhart (1892) observed asci measuring 75 × 15 µm, Dennis (1978): 90 × 17 µm, and



Figs. 9-13. Ascomycetes of Sonora, Mexico. 9-11: *Hysterium insidens*, 9: hysterothecia, 10: apical part of ascus with ascospores, 11: ascospore. 12-13: *Hysterium truncatulum*, 12: hysterothecia, 13: partial section of asci with ascospores.

Sivanesan (1984): 120 × 10-18 μm. As no further differences were noted, our specimens were identified as *H. insidens.*

Hysterium truncatulum Cooke & Peck, in Cooke, Bull. Buffalo Soc. Nat. Sci. 3: 33. 1875

Hysterothecia 1.5-2 × 0.8-2.5 mm, erumpent, elongate to elliptical-fusoid, with obtuse, carbon-like tips, center dotted with longitudinal opening when closed, dome-like appearance when open, external surface dark with radially striated margins and speckled with reddish dust. In open specimens, the hymenium is orangy red. Asci 220-345 × 15-20 μm, cylindrical-clavate, bitunicate, base with a short stipe, inamyloid. Ascospores 31-43 × 10-13 μm, cylindrical-ellipsoid with tips rounded to occasionally subapiculate, dark brown to reddish brown, triseptate, some with central cells darker and more compact at central septum level, uniseriate in the ascus.

SPECIMENS STUDIED: LOCALITY 6, *leg.* F. Méndez & S. Gómez, 27.VIII.2005, on the bark of branches and fallen trunks in subtropical scrub, *CESUES 6334*, *Chacón-5692* (*XAL*).

OBSERVATIONS: The Sonoran collection agrees with the descriptions of Saccardo (1883) and Ellis & Everhart (1892). The distinguishing characteristics for this taxon are its dark brown, tri-septate ascospores, some with dark cells in the center and light ones at the tips. Guzmán (1983) recorded the first *Hysteriales* for Mexico: *Hysterium angustatum* Pers. for the Mexican state of Quintana Roo.

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Literature cited

Barr ME. 1990. Some dictyosporus genera and species of *Pleosporales* in North America. Memoirs of the New York Botanical Garden 62: 1-92.

Breitenbach J, Kränzlin F. 1981. Fungi of Switzerland, Vol. I *Ascomycetes*. Verlag Mykologia, Lucerna.

Chacón S. 2004. Claves para los géneros y especies de *Diatrypales* (*Fungi: Ascomycotina*) de México. Brenesia 62: 41-46.

Chacón S. 2005. El género *Diatrype* en México, especies conocidas y nuevos registros. Revista Mexicana de Micología 20: 5-12.

Chacón S, Guzmán G. 1983. *Ascomycetes* poco conocidos en México. Boletín de la Sociedad Mexicana de Micología 18: 183-218.

Dennis RWG. 1978. British *Ascomycetes*. J. Cramer, Vaduz.

Ellis JB, Everhart BM. 1892. North American Pyrenomycetes. Johnson Reprint Co., Newfield, New Jersey.

Esqueda M, Pérez-Silva E, Coronado-Andrade M. 1992. Nuevos registros de Pezizales para Sonora. Revista Mexicana de Micología 8: 43-54.

Guerra JM. 1998. Ajos-Bavispe reserva forestal nacional y refugio de fauna silvestre. Entorno (2). In: http://www.imades.org/entorno/entorno02/ajos.htm (Febrero 2005).

Guzmán G. 1983. Los hongos de la península de Yucatán II. Nuevas exploraciones y adiciones micológicas. Biótica 8: 71-100.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth and Bisby's dictionary of the fungi. 9th ed. CAB International, Wallingford-Oxon.

Lizárraga M, Moreno G, Esqueda M, Sánchez A, Coronado M. 2007. *Myxomycetes* from Sonora, 3: National forest reserve and wildlife refuge, Ajos-Bavispe. Mycotaxon 99: 291–301.

Montaño A, Valenzuela R, Sánchez A, Coronado M, Esqueda M. 2006. *Aphyllophorales* de Sonora, México, I. Algunas especies de la reserva forestal nacional y refugio de fauna silvestre Ajos-Bavispe. Revista Mexicana de Micología 23: 17-26.

Moreno G, Lizárraga M, Esqueda M, Pérez-Silva E, Herrera T. 2006. *Myxomycetes* de Sonora, México. II: Reserva forestal nacional y refugio de fauna silvestre Ajos-Bavispe. Revista Mexicana de Micología 22: 13-23.

Pérez-Silva E, Esqueda-Valle M, Armenta-Calderón A. 1996. *Ascomycetes* de Sonora I: Discomycetes y Pyrenomycetes. Revista Mexicana de Micología 12: 97-106.

Rappaz F. 1987. Taxonomie et nomenclature des diatrypacées à asques octosporés 1. Mycologia Helvetica 2: 285-648.

Saccardo PA. 1883. Sylloge fungorum omnium hucusque cognitorum. Vol. II. Patavii.

San Martín F, Lavín P, Esqueda M, Pérez-Silva E. 1999a. Additions to the known *Xylariaceae* (*Hymenoascomycetes, Xylariales*) of Sonora, Mexico. Mycotaxon 70: 77-82.

San Martín F, Rogers JD, Lavín P, Pérez-Silva E, Esqueda M. 1999b. New records of *Xylariaceae* of Sonora, Mexico. Mycotaxon 71: 129-134.

San Martín F, Lavín P, Esqueda M. 1999c. *Distorimula* a new ascomycete genus from Sonora, Mexico. Mycotaxon 73: 263-265.

Sivanesan A. 1984. The bitunicate *Ascomycetes* and their anamorphs. J. Cramer, Vaduz.

Seaver JF. 1910. The Hypocreales of North America III. Mycologia 2: 48-92.

Seaver JF. 1978. The North American cup-fungi (inoperculates). [2nd facsimile reproduction] Lubrecht & Cramer, Monticello, New York.

Welden AL. Guzmán G. 1979. Segunda lista de los hongos, líquenes y mixomicetos de las regiones de Uxpanapa, Coatzacoalcos, Los Tuxtlas, Papaloapan y Xalapa (México). Boletín de la Sociedad Mexicana de Micología 12: 59-102.

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Lepiotaceous fungi in California, U.S.A.
6. *Lepiota castanescens*

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Abstract—*Lepiota castanescens* is a red-staining species in the *Leucoagaricus/Leucocoprinus* clade of the *Agaricaceae*. It is very close to the European *Leucoagaricus croceovelutinus* and the Australian *Lepiota haemorrhagica*. Basidiocarps stain red with ammonia, KOH and age, spores have an apical papilla, cheilocystidia are lageniform to clavate with apical excrescence; and the pileus covering outside the central patch is made up of repent hyphae of different length and diameter. The type collection and modern collections are described.

Key words—biodiversity, DNA sequence-based phylogeny, morphology, western North America

Introduction

The mycoflora of California is rich in lepiotaceous fungi, the white-spored agaricoid members of the *Agaricaceae* (Sundberg 1967, Vellinga 2004a, b). In particular the *Leucoagaricus/Leucocoprinus* clade is represented by many species (Vellinga 2004a, b). One of these, a small but striking species whose basidiocarps turn brick to dark red with age and stain orange-red with ammonia, is identified as *L. castanescens*. The European species *La. croceovelutinus* (Bon & Boiffard) Bon & Boiffard, and the Australian species *Lepiota haemorrhagica* Cleland are its sister taxa in sequence analyses (Vellinga 2004a), and together they form a small and distinct clade, which differs from species such as *La. brunnescens* (Peck) Bon, *La. badhamii* (Berk. & Broome) Singer, and *La. americanus* (Peck) Vellinga (Vellinga 2004a, b) in the staining reaction. The basidiocarps of those species also change color when the cells are damaged, but they ultimately stain black(ish) and have a green reaction in ammonia and KOH.

Here we describe some features of the type collection, give a modern description of the species, and discuss the similarities and differences with its close relatives.

Material and methods

Terminology for descriptive terms follows Vellinga (2001). Munsell (1976) indicated by Mu. in front of the code, and Ridgway (1912) (colour names are in " ") have been used to standardize colours.

The notation [90,6,6] indicates that measurements were made on 90 spores in six samples from six collections; avl stands for average length, avw for average width, Q for quotient of length and width and avQ for average quotient. The abbreviation *L.* is used for *Lepiota* and *La.* for *Leucoagaricus*. Herbarium abbreviations are according to Holmgren & Holmgren (1998).

Standard molecular methods were applied (e.g. Vellinga et al. 2003); the primer pair ITS1F and ITS4 were used both for PCR and sequencing (Gardes & Bruns 1993), and the phylogenetic analyses were performed with PAUP* version 4.0 (Swofford 2002). All nrITS sequences have been deposited in GenBank; accession numbers are listed with the collections.

Taxonomic part

Lepiota castanescens Murrill, Mycologia 4: 234. 1912. **Figs 1-4, 6, 7**

DESCRIPTION OF TYPE COLLECTION (Murrill 397 (NY)) (figs 1, 6):

Murrill (1912): "Pileus small, thin, convex to subexpanded, prominently umbonate, 2-3 cm. broad; surface dry, densely appressed-fibrillose, white to rose-colored, glabrous and darker-red on the umbo, the entire surface changing to castaneous on drying; lamellae free, crowded, narrow, plane, white, becoming fumosous on drying; spores ellipsoid, smooth, pointed, strictly hyaline, 7-8 × 3-4 μ; stipe tapering upward, slender, slightly fibrillose, hollow, about 6 cm. long and 2-5 mm. thick, white or rose-tinted, changing to castaneous on drying; annulus superior, fixed, ample, persistent, white, changing to castaneous on drying."

BASIDIOSPORES [20,1,1] in side-view 7.1-8.4 × 4.1-4.7 μm, avl × avw = 7.6 × 4.5 μm, Q = 1.55-1.86, avQ = 1.7, oblong-amygdaloid often with small apical papilla, in frontal view ovoid with or without papilla, congophilous, slowly colouring red-brown in Melzer's reagent, metachromatic in Cresyl Blue, uni-guttulate, slightly thick-walled. BASIDIA 4-spored. Lamella edge sterile; CHEILOCYSTIDIA hard to revive, 23-35 × 9-15 μm, clavate, with 7-25 × 5 μm moniliform to cylindrical excrescence, with brownish content in ammonia. PILEUS COVERING structure hard to discern, with chains of isodiametrical cells and elongate hyphae present; pigment brown and intracellular. CLAMP CONNECTIONS not observed.

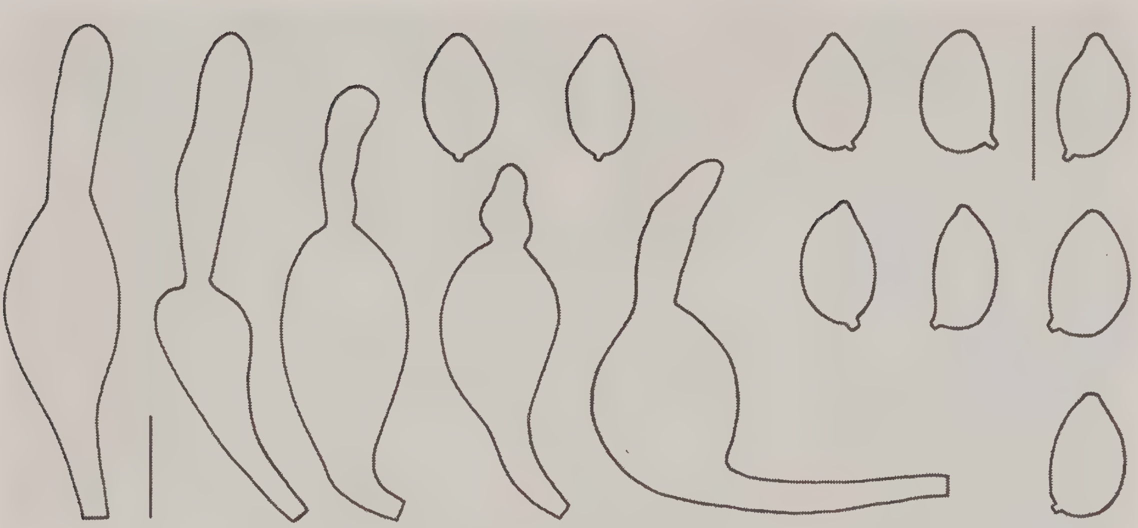

Fig. 1. *Lepiota castanescens* – spores and cheilocystidia from type collection. Scale bars 10 µm.

DESCRIPTION OF MODERN MATERIAL (figs 2-4, 6):

CHARACTERISTICS—Basidiocarps slender, with relatively small pileus, whitish at first, but discolouring orange-red to red in all parts when touched and with age; lamellae first yellow then orange with ammonia.

PILEUS 8-45(-50) mm, when young truncate-conical or hemispherical, expanding to plano-convex, applanate and finally plano-concave, most often with low, broad umbo, sometimes set in shallow depression, rarely without umbo, smooth or velvety-felted to plush-like tomentose at centre, around centre with radially arranged more or less coarse fibrillose or cobwebby scales, when young whitish, but soon discolouring to dark orange-brown, red-brown to almost black at centre (Mu. 2.5 YR 3/4, 2.5 YR 3-4/4; "Vandyke brown", "liver brown" to "burnt umber") and at fibrils (Mu. 2.5 YR 6/6-8, 2.5 YR 4/6; "Verona brown", "walnut brown", "hay's russet" to "liver brown"); background white at first, changing to orange with rain, age, or bruising (Mu. 2.5 YR 4/8; "carrot red"); margin fibrillose when young, exceeding lamellae. LAMELLAE, L = around 50, l = 1(-3), moderately crowded, free, rounded near stipe and slightly ventricose, whitish at first, but soon pale pink ("light ochraceous-buff", "apricot buff") and flushed orange-red in places to completely red ("orange cinnamon" to "kaiser brown"); edge conspicuously set with cystidia, white at first, changing to red when touched, and with age. STIPE 25-80(-220) × 1-7.5 mm, cylindrical but widening downwards, especially in lower 1 cm, up to 1.5 times width at half length, when young whitish, to slightly pinkish, innately lengthwise fibrillose, becoming red instantaneously when touched (Mu. 10 R 5-4/8), and orange-red to red with age and other damage (rain e.g.), concolorous with pileus, hollow. ANNULUS funnel-shaped, or with a small ascending, rarely descending, cuff with

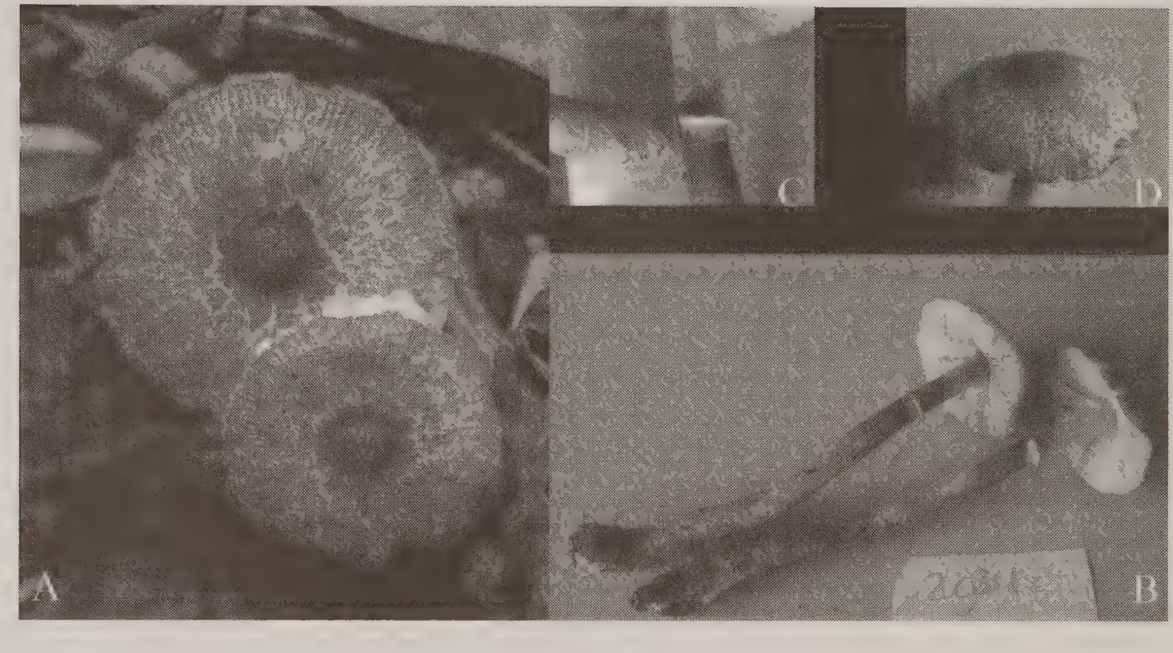

Fig. 2. *Lepiota castanescens* – A. collection ecv3077; B, C and D. collection ecv2934. All photos by John Lennie.

a (small) flaring part, white at first, changing to red to red-brown, especially at outside, and on edge and there almost black; inner part staying white for a longer time. CONTEXT very thin in pileus, whitish, not or changing to carrot orange to light scarlet (“light ochraceous-salmon” to “vinaceous-rufous”) when cut; in stipe whitish, reddish when cut. SMELL none. TASTE not recorded. SPORE PRINT color white. CHEMICAL REACTIONS: Ammonia on lamellae first yellow, then orangey red.

BASIDIOSPORES [105,7,7] in side view 5.9-8.3 × 3.5-4.7 µm, avl × avw = 6.8-7.3 × 4.0-4.2 µm, Q = 1.5-2.1, avQ = 1.66-1.78, amygdaliform with small apical papilla and conspicuous hilar appendage, in frontal view oblong with apical papilla, slightly thick-walled, often with one, more rarely with two, guttules, dextrinoid, congophilous, and metachromatic in Cresyl blue, without germ pore. BASIDIA 14-26 × 6-9 µm, the majority 4-spored, a few 2-spored, close to lamella edge with rusty brownish contents. Lamella edge sterile; CHEILOCYSTIDIA 17-62 (in total) × 7-19 µm, clavate, narrowly lageniform, lageniform to utriform, often narrowly clavate gradually or abruptly changing into 5-30 × 3-8 µm cylindrical, moniliform to capitate, apical excrescence, with reddish rusty brown contents in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING at umbo a dense layer of iso-diametrical cells, 8-30 × 7-30 µm giving rise to occasional elongate cylindrical or slightly fusiform cells, 25-45 × 7-13 µm; around umbo a cutis of strands of repent hyphae with uplifted terminal elements, more sparsely covering pileus surface and with thinner hyphae towards margin; terminal elements cylindrical to slightly inflated, with rounded apex, 27-90 × 8-12.5 µm; all elements of pileus covering with dark red-brown walls, rarely incrusted-

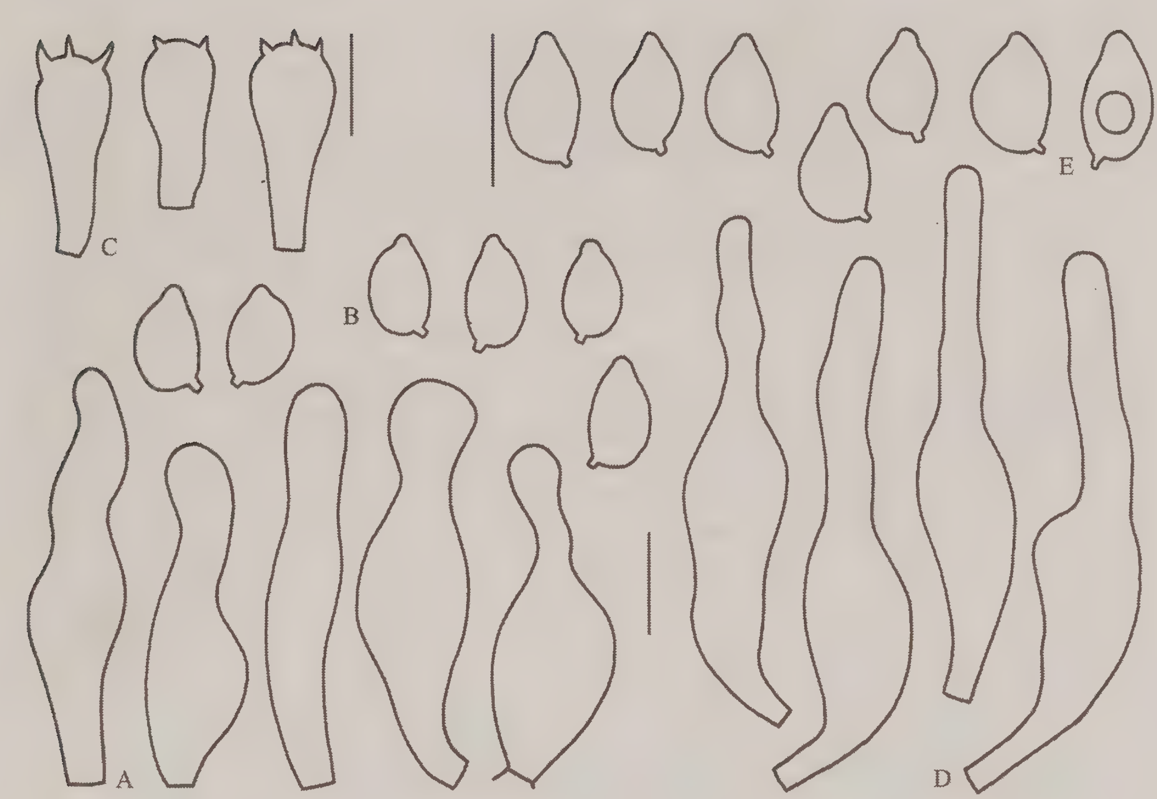

Fig. 3. *Lepiota castanescens*, microscopical characters – spores (B and E), basidia (C) and cheilocystidia (A and D).
A-C from collection ecv3424; D and E from collection R. Pastorino.
Scale bars 10 µm.

pigmented, and some cells with intracellular pigment. STIPE COVERING a cutis of cylindrical cells, 3-5 µm wide, with brown to orange-brown pigments, some with excrescences. CLAMP CONNECTIONS absent.

HABITAT & DISTRIBUTION – Gregarious in small groups, rarely solitary, terrestrial and saprotrophic, in various forest types, e.g. Monterey Cypress (*Cupressus macrocarpa*) groves, in mixed *Alnus-Picea sitchensis* forest, or mixed conifer coastal forest. Known from Washington, and coastal California, reported from Humboldt Co. in the north to San Mateo Co., south of San Francisco.

COLLECTIONS EXAMINED – U.S.A., Washington, around Seattle, 20 Oct.–1 Nov. 1911, W.A. Murrill 397 (Holotype, NY); King Co., Seattle, Fauntleroy Park, 27 Oct. 2003, J.M. Birkebaek 80 (WTU; Genbank nrITS EU166350). California, Humboldt Co., Patrick's Point S.P., 23 Sept. 1966, W.J. Sundberg 777 (SFSU; as *L. rubrofolia*); Patrick's Point S.P. near Mussel Rock, 23 Oct. 2003, E.C. Vellinga 3076 and 3077 (UC); Prairie Creek S.P., 23 Sept. 1966, W.J. Sundberg 790 (SFSU; as *L. rubrofolia*); ibidem, 8 Oct. 1966, W.J. Sundberg 881 (SFSU; as *L. rubrofolia*); Prairie Creek Redwood NP, near Wolf Creek, 26 Oct. 2003, E.C. Vellinga 3115; Mendocino Co., Jackson State Demonstration Forest, 22 Nov. 2003, E.C. Vellinga 3131 (UC; Genbank nrITS EU166351); Marin Co., Audubon Canyon Ranch, Picher Canyon, 6 Dec. 1977, Calhoun 77-394 (SFSU; as *L. rubrofolia*); ibidem, Galloway Canyon, 13 Nov. 1980, Calhoun 80-168 (SFSU; as *L. rubrofolia*); Muir Woods, 20 Nov. 1966, Madden 539 (SFSU; as *L. rubrofolia*); Point Reyes, near Bolinas,

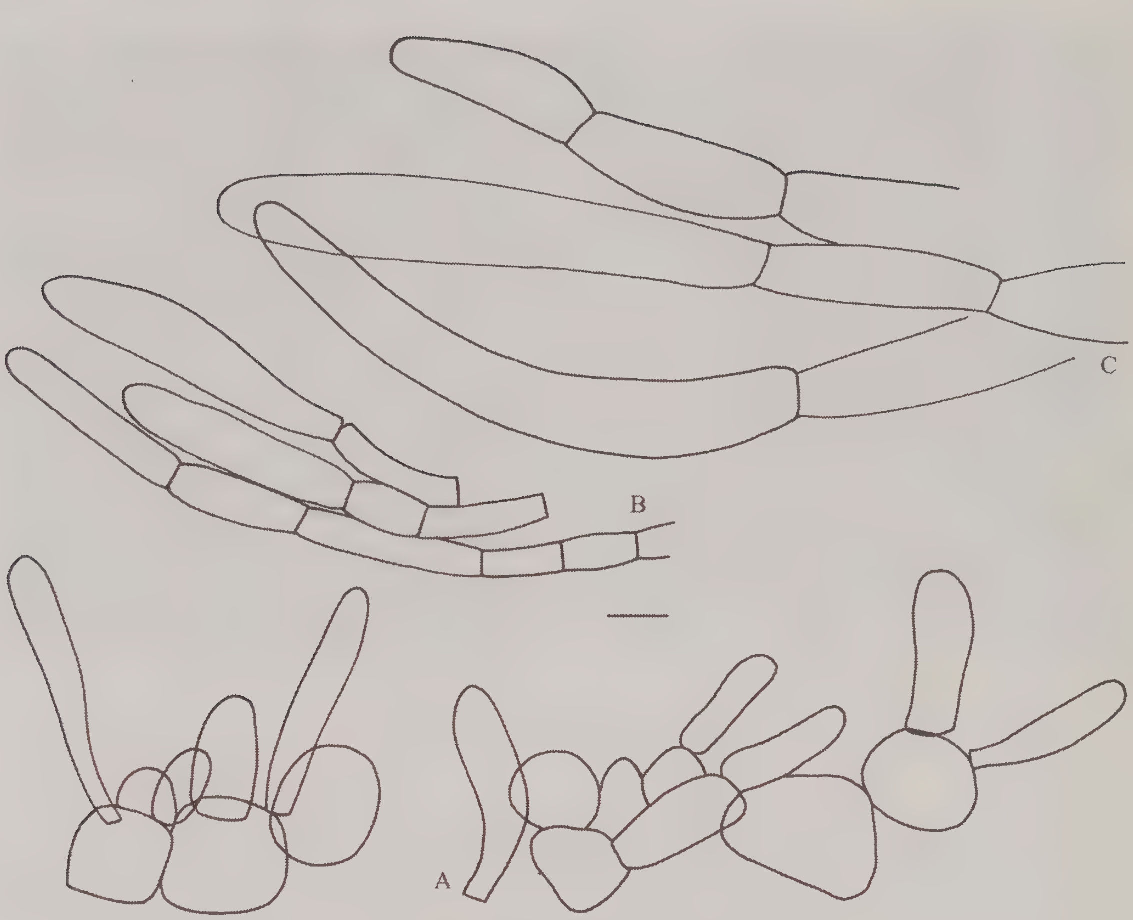

Fig. 4. *Lepiota castanescens*, pileus coverings – A. centre of pileus (collection ecv3142); B and C. radiating fibrils around umbo (B from collection ecv3424; C from collection R. Pastorino). Scale bar 10 µm.

25 Nov. 2003, R.L. Pastorino (UC; Genbank nrITS EU166352); Contra Costa Co., Tilden regional park, 23 Nov. 2001, E.C. Vellinga 2739 (UC); San Mateo Co., San Francisco Watershed, 10 Dec. 1999, E.C. Vellinga 2398 (UC); ibidem, 8 Dec. 2000, E.C. Vellinga 2596 (UC; Genbank nrITS AF482860, as '*Leucoagaricus* sp.'); ibidem, 13 Dec. 2002, E.C. Vellinga 2934 (UC); ibidem, 5 Dec. 2003, E.C. Vellinga 3142; ibidem, 2 Dec. 2005, E.C. Vellinga 3424 (UC).

ADDITIONAL COLLECTIONS EXAMINED

Leucoagaricus croceovelutinus – The Netherlands, prov. Noord-Holland, Aerdenhout, Naaldenveld, 27 Oct. 1977, E. Kits van Waveren (L); Amsterdamse Waterleidingduinen, Vogelenzang, 13 Oct. 1979, C. Bas 7561A (L); ibidem, 18 Sept. 1982, E.C. Vellinga 473 (L); prov. Zuid-Holland, isl. of Voorne, Westvoorne, Quackjeswater, 7 Oct. 1980, J. Schreurs 531 (L); prov. Limburg, Bemelen, 9 Oct. 1991, E.C. Vellinga 1779 (L); Cadier en Keer, 6 Oct. 2004, H.A. Huijser (herb. Huijser; Genbank nrITS EU166349); Elsloo-Geulle, Bunderbos, 19 Sept. 1998, E.C. Vellinga 2229 and 2243 (L) (Genbank nrITS AF482862, LSU AF482889).

Lepiota haemorrhagica – Australia, Victoria, 52 km No of Orbost on the Bonang Road, Martins Creek, alt. 320 m, 17 May 2000, K.R. Thiele 2652 (MEL) (Genbank nrITS AY176374, LSU AY176375).

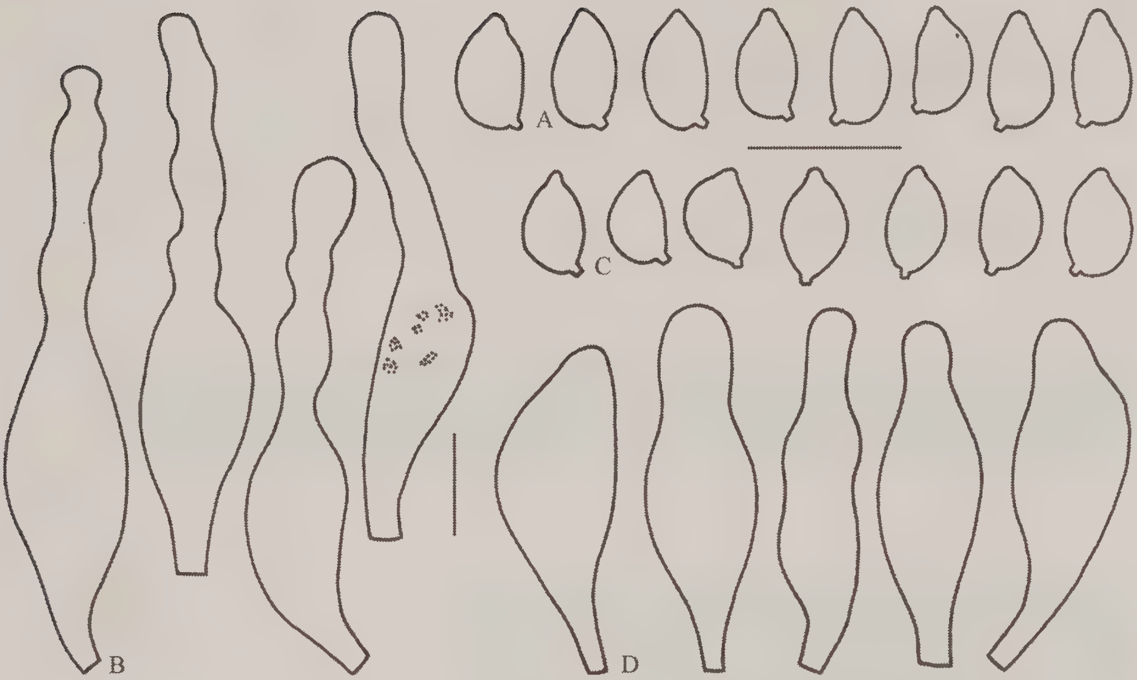

Fig. 5A, B. *Leucoagaricus croceovelutinus* – A. spores; B. cheilocystidia (collection H.A. Huijser, 6 Oct. 2004). Scale bars 10 µm.

Fig. 5C, D. *Lepiota haemorrhagica* – C. spores; D. cheilocystidia (collection K.R. Thiele 2652). Scale bars 10 µm.

COMMENTS – Murrill's description and the type collection of *L. castanescens* fit very well what we have been calling either "*L. rubrofolia*" (Sundberg 1967), "*L. carmineobasidia*" (Vellinga 2004a) (both names are manuscript names by Sundberg (1967)) or more recently "American representatives of *La. croceovelutinus*". The type collection was studied previously by Smith (1966), whose spore sizes are a little smaller than what we found.

Lepiota castanescens is easy to recognize because of its reddish colours and the distinct central patch on the pileus surrounded by fibrillose scales. Microscopically the combination of spore shape, cystidia and structure of the pileus covering is characteristic.

Only in very early stages are the basidiocarps predominantly white, but the slightest touch changes them into reddish mushrooms. The specimens display a huge range in size, from minute with a slender 1 mm wide stipe and an 8 mm wide pileus to robust with a long and 7.5 mm wide stipe and an up to 50 mm wide pileus. Microscopically there is also huge variation, especially in size and shape of the cheilocystidia (fig. 3).

The structure of the pileus covering at the umbo differs strikingly from that of the squames surrounding the umbo. The same is true for the other two species in the group. The descriptions of the pileus covering of *La. croceovelutinus* vary from author to author (compare for instance the original description by Bon &

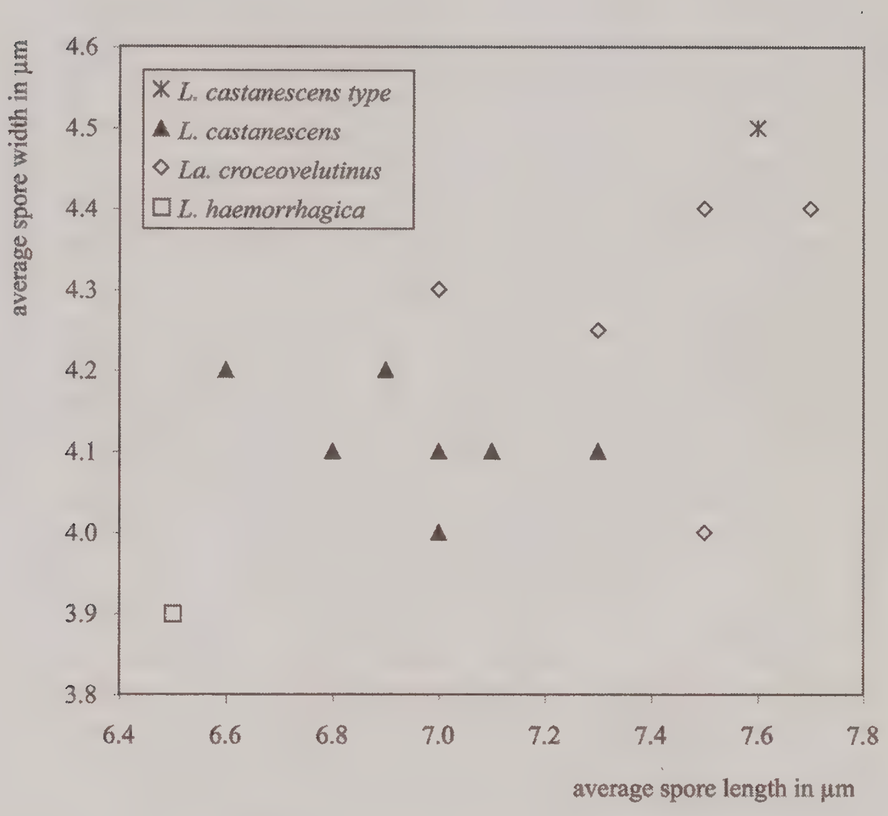

Fig. 6. Scatter diagram of average spore sizes for collections of *L. castanescens* including the type, *La. croceovelutinus*, and *L. haemorrhagica*.

Boiffard (1972) and those by Candusso & Lanzoni (1990), Kelderman (1994), and Reid (1990)). This discrepancy is caused by the fact that the structure of the umbo and that of the fibrillose covering surrounding it are very different. In *L. castanescens* the central calotte is made up of globose to iso-diametrical cells with emerging cylindrical elements (fig. 4A), whereas the scales are composed of repent radially arranged hyphae (fig. 4B, C).

The amygdaloid spore shape with the apical papilla is not unique in the *Agaricaceae*: *Leucoagaricus pepinus* Heinem. with spores (8.5-)10.2-14.5(-17) × (5.5-)6.5-8.2(-8.5) µm (Heinemann 1973) and *Leucocoprinus pepinosporus* Heinem. with spores 11.2-13.4 × 7.4-8.1 µm (Heinemann 1977) are other examples, but both lack the striking colour changes of *La. croceovelutinus*, and have much bigger spores with a bigger papilla.

Several species in *Leucoagaricus* section *Piloselli* (Kühner ex) Singer possess similarly shaped cheilocystidia (e.g. *L. fuliginescens* Murrill and *La. badhamii*), but these species differ in their reaction with ammonia.

Lepiota castanescens forms together with *La. croceovelutinus* and *L. haemorrhagica* a distinct group in the *Leucoagaricus/Leucocoprinus* clade, apparently not closely related to species in *Leucoagaricus* sect. *Piloselli* such as *La. badhamii* with a green reaction in ammonia and spore without a germ pore

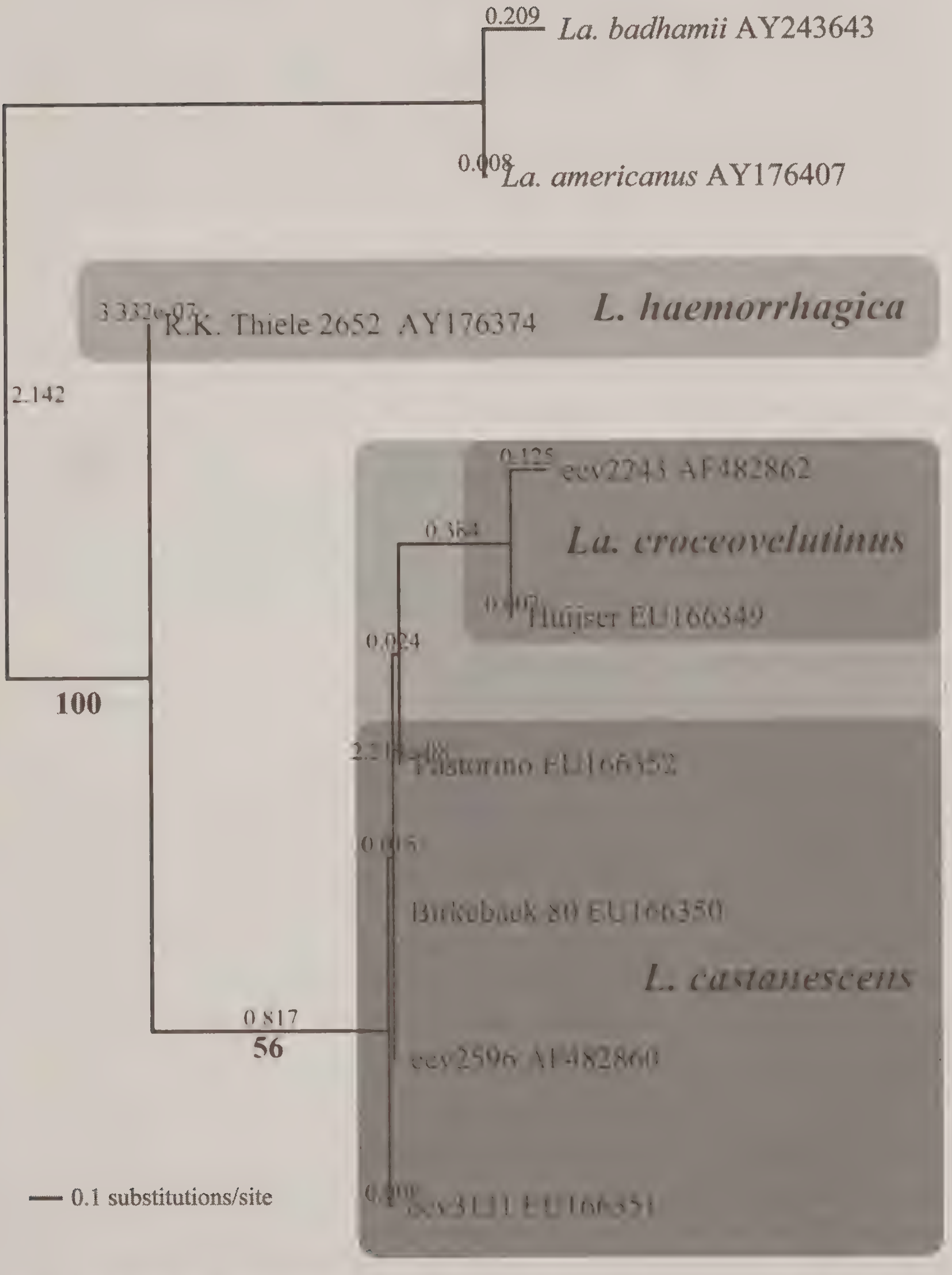
0.209
La. badhamii AY243643
0.008
La. americanus AY176407
2.142
100
3.332e-07
R.K. Thiele 2652 AY176374
L. haemorrhagica
0.125
ecv2243 AF482862
0.364
La. croceovelutinus
0.007
Huijser EU166349
0.024
Pasturino EU166352
0.015
Birkebaek 80 EU166350
L. castanescens
0.817
56
ecv2596 AF482860
0.1 substitutions/site
0.009
ecv3111 EU166351

Fig. 7. Phylogenetic relationships among reddening species of *Leucoagaricus* inferred from Maximum Likelihood analyses of a dataset of nrITS sequences; 60 characters were informative, the HKY85 variant was used as model. Bootstrap values (in bold) are based on 100 replicates. *Leucoagaricus badhamii* and *La. americanus* were used as outgroup. All sequences have been deposited in Genbank.

and *La. americanus* and allies, also with a green reaction with ammonia, but with spores with a germ pore.

Leucoagaricus croceovelutinus differs in nrITS sequences, and in general has more robust and less slender basidiocarps than *L. castanescens*. The long slender stipes of the latter might be caused by environmental factors like a thick litter layer. Besides the differences in nrITS, also gene sequences of RPB2 show differences in base pair composition between the two North American and European collections sequenced (data not shown).

Lepiota haemorrhagica from Australia has smaller cheilocystidia (fig. 5C, D) than *La. croceovelutinus* (fig. 5A, B) and *L. castanescens* (fig. 3D), but is in general appearance very similar to both (Cleland 1931, 1934; Grgurinovic 1997). The average spore size for the one collection we studied is given in fig. 6, but Grgurinovic (1997) listed bigger and wider spores for the type collection: 6.6-9.6 × 4.0-5.8 µm, on average 7.4 × 4.9 µm. The differences in nrITS sequences are quite small. The three taxa differ mostly at the molecular level and in geography; the morphological differences are small and subtle. Despite an extensive literature review we have not been able to find other species with this set of characters. It is remarkable that the closest relative of the Northern Hemisphere species is found in Australia.

We refrain from making the combination in *Leucoagaricus* for *L. castanescens* and *L. haemorrhagica* as the taxonomy of the *Leucoagaricus/Leucocoprinus* clade is still in flux (see Vellinga 2004b).

The actual distribution areas of all three taxa are not known. *Lepiota castanescens* is known from Washington and coastal, northern California. It has not been found in the eastern states of the U.S.A. The European taxon is known from western Europe (from Denmark south to Italy and Spain (e.g. Heilmann-Clausen 1992, Lange 1995, Bon 1993, Chiusa 1999, Candusso & Lanzoni 1990, Consiglio et al. 2004, Bolets Catalunya 1998), and from the United Kingdom eastwards to Hungary (e.g. Reid 1990, Vellinga 2001, Babos 1995). *Lepiota haemorrhagica* is known from South Australia and Victoria (Cleland 1931, 1934; Grgurinovic 1997, Shepherd & Totterdell 1988).

Acknowledgements

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Literature cited

Babos M. 1995. Studies on Hungarian *Lepiota* s.l. species. VII. Doc. mycol. 25 (98-100): 19-27.

Bolets de Catalunya 17: pl. 834. 1998. *Leucoagaricus croceovelutinus.*

Bon M. 1993. Flore mycologique d'Europe 3. Les Lépiotes. Doc. mycol. Mémoire hors série 3: 1-153. *Lepiotaceae* Roze.

Bon M, Boiffard J. 1972. Lépiotes des dunes Vendéennes. Bull. trimest. Soc. mycol. Fr. 88: 15-28.

Candusso M, Lanzoni G. 1990. *Lepiota* s.l. Fungi europaei 4. Giovanna Biella, Saronno. 743 pp, 80 pl.

Chiusa L la. 1999. *Lepiotaceae* Roze. 3o contributo alla conoscenza di specie interessanti. Riv. Micol. 42 (mistakenly as 41): 35-55.

Cleland JB. 1931. Australian fungi: notes and descriptions. – No. 8. Trans. Proc. Roy. Soc. South Australia 55: 152-160.

Cleland JB. 1934. Toadstools and mushrooms and other larger fungi of South Australia. Part 1. Handbooks committee of South Australia. Government printer, South Australia. 178 pp.

Consiglio G, Contu M, Testoni A. 2004. Alcune species rare o interessanti del genere *Leucoagaricus* (*Lepiotaceae*) osservate in Italia. Micol. e Veget. Medit. 19: 131-145.

Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. Mol. Ecol. 2: 113-118.

Grgurinovic CA. 1997. Larger fungi of South Australia (Adelaide, South Australia: Botanic Gardens of Adelaide and State Herbarium & Flora and Fauna of South Australia Handbooks Committee). 725 pp.

Heilmann-Clausen J. 1992. Rødmende furehatte (*Leucocoprinus* sekt. *Anomali*) i Danmark. Svampe 26: 17-21.

Heinemann P. 1973. Leucocoprinées nouvelles d'Afrique centrale. Bull. Jard. bot. natn. Belg. 43: 7-13.

Heinemann P. 1977. Leucocoprinées nouvelles d'Afrique centrale II. Bull. Jard. bot. natn. Belg. 47: 83-86.

Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/

Kelderman PH. 1994. Parasolzwammen van Zuid-Limburg. *Lepiota* s.l. excl. *Macrolepiota.* Natuurhistorisch Genootschap in Limburg, Maastricht. 207 pp.

Lange C. 1995. The genus *Leucoagaricus* in Denmark; distribution and ecology. Doc. mycol. 25 (98-100): 249-256.

Munsell soil color charts. 1975. Baltimore.

Murrill WA. 1912. The *Agaricaceae* of the Pacific Coast II. Mycologia 4: 231-262.

Reid DA. 1990. The *Leucocoprinus badhamii* complex in Europe: species which redden on bruising or become green in ammonia fumes. Mycol. Res. 94: 641-670.

Smith HV. 1966. Contributions toward a monograph on the genus *Lepiota*, I. Type studies in the genus *Lepiota*. Mycopath. & Mycol. appl. 29: 97-117.

Shepherd CJ, Totterdell CJ. 1988. Mushrooms and toadstools of Australia. Inkata Press, Melbourne. 162 pp.

Sundberg WJ. 1967. The family *Lepiotaceae* in California. Master's thesis, San Francisco State University. 219 pp.

Swofford DL. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.

Vellinga EC. 2001. *Leucoagaricus*. In Noordeloos ME, Kuyper ThW, Vellinga EC (eds). Flora agaricina neerlandica 5: 85-108. A.A. Balkema Publishers, Lisse/Abingdon/Exton (PA)/Tokyo. 169 pp.

Vellinga EC. 2004a. Ecology and distribution of lepiotaceous fungi – a review. Nova Hedwigia 78: 273-299.

Vellinga EC. 2004b. Genera in the family *Agaricaceae* – Evidence from nrITS and nrLSU sequences. Mycol. Res. 108: 354-377.

Vellinga EC, de Kok RPJ, Bruns TD. 2003. Phylogeny and taxonomy of *Macrolepiota* (*Agaricaceae*). Mycologia 95: 442-456.

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Taxonomy of the fungus commonly known as *Stropharia aurantiaca,* with new combinations in *Leratiomyces*

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Abstract — The taxonomy and nomenclature of the fungus commonly referred to as *Stropharia aurantiaca* was investigated. Molecular analysis of the ribosomal RNA large subunit gene confirmed the exclusion of the species from *Stropharia*. The results from further molecular and morphological comparison with type species indicated that '*S. aurantiaca*' is congeneric with a number of other taxa currently placed in *Leratiomyces, Stropharia* and *Weraroa*. These taxa are transferred to *Leratiomyces* and an emended diagnosis and brief discussion of this genus are provided.

Key words — LSU, stropharioid, woodchip, sequestrate

Introduction

The suitability of woodchip mulch as a substratum for the colonisation of fungi has become increasingly evident in recent years, with an ever-growing number of species being recorded from it from many parts of the world. During the past twenty years or so the mulching of garden beds with woodchips has become a routine practice in Britain (Shaw et al. 2004), providing a specialised habitat that is considered by Shaw & Kibby (2001) to be unique and not otherwise found in nature. Either as mulch or in composting piles, woodchip proves surprisingly ideal for a wide range of fungi from various groups, most conspicuously amongst the larger fungi, including common species found more usually in other habitats, and otherwise scarce species which can fruit in abundance. In Britain, these are exemplified by the bird's-nest fungi *Cyathus olla*, *C. striatus* and

Crucibulum laeve, and by agarics such as *Volvariella gloiocephala*, *V. hypopithys*, and *Macrocystidia cucumis*. Some woodchip fungi have even proved to be first recorded from this substratum, notably *Melanoleuca verrucipes* (Shaw & Kibby 2001) and *Agrocybe putaminum* (Henrici 2001) in Britain, while others have proved to be undescribed and of unknown origin. Perhaps the most recent example of this is *Agrocybe rivulosa*, recently described from woodchips in the Netherlands (Nauta 2003). This species was first recorded in Britain from Staffordshire in 2004 and is now spreading rapidly in England with at least 8 collections to date (Henrici 2006a,b). *Psilocybe cyanescens* was perhaps the first of the introduced woodchip fungi to be recorded in Britain, being first described from the Royal Botanic Gardens, Kew, in 1911 (Dennis & Wakefield 1946). An unpublished compilation of woodchip fungi on file at Kew now totals at least 250 species. Their origin, ecology and mode of dispersal are all little understood aspects in need of further study.

One of the commonest and most distinctive of the woodchip fungi has been known as *Stropharia aurantiaca*, a species readily recognised by its orange cap and dark spores, often fruiting in large numbers over extensive areas of woodchip mulch (e.g. Pegler & Legon 1998, Shaw & Kibby 2001). Ironically, it has become clear that this distinctive and widespread species has been consistently misidentified and the name misapplied, and the search for an appropriate name has proved difficult. Guzmán (1983) noted this confusion, and the problem was recently highlighted by Fortey (2004), who has carefully and clearly summarised the situation. *Stropharia aurantiaca*, which unfortunately lacks type material and is represented only by a painting (reproduced in Fortey 2004), has a similar orange cap but is a slender agaric as illustrated and described by Cooke (1887, as *Agaricus squamosus* f. *aurantiacus*). This may also occur on woodchips but can be identified with *S. thrausta* (= *S. squamosa* var. *thrausta*), a scarce taxon which, based on morphology and DNA analysis, has been shown by Jahnke (1984) to be no more than a colour form of *S. squamosa*. This taxon, morphologically identical with *S. squamosa*, lacks chrysocystidia whereas the species in question has abundant chrysocystidia and is quite distinct (Fortey 2004). It continues to be reported worldwide and is now known throughout much of Europe (Noordeloos 1999), North America (Arora 1986), Australia (Daams 1991) and New Zealand (Taylor 1981). In Britain, it was first recognised in 1957, being reported from sawdust in Somerset by Orton (1960) who noted the abundant chrysocystidia. Reid (1966) described and illustrated a subsequent collection from Surrey in November 1957. It is now a regular and often abundant coloniser of woodchip mulch, occasionally also found away from woodchip in natural habitats. However, its mode of dispersal and colonisation are, as for other wood-chip fungi, little understood. At the Royal Horticultural Society's garden at Wisley in Surrey, DNA analysis of mulch and

Table 1. Specimen details and GenBank numbers for sequences generated in this study.

Species	Locality	Collector	Voucher	GenBank
Stropharia aurantiaca	UK, Surrey, Wisley, Royal Horticultural Society Garden	Bridge & Prior, 2004	KC1700 (culture)	AM747624
Stropharia percevalii	UK, Surrey, Leatherhead	Shaw, 2000	K(M)77890	AM747625
Weraroa cucullata	California, Sierra County, Chapman Creek	Saylor, Cazares & Castellano, 1987	PDD 58490 (Trappe 9507)	EU019232
Weraroa erythrocephala	New Zealand, Waipori Valley	Beever, Pennycook & Johnston, 2000	PDD 71777 (Beever 1879)	EU019233
Weraroa novae-zelandiae	New Zealand, Ketetahi	Lebel & Camacho, 1995	PDD 65096 (Trappe 15563)	EU019234
Weraroa novae-zelandiae	New Zealand, Waitakere Range	Beever , 1997	PDD 67194 (Beever 1547)	EU019235
Leratiomyces atrovirens	New Caledonia, Monts des Koghis	Johnston & Beever, 2003	PDD 88863 (Beever 2202)	EU183546

soil showed somewhat inconsistent results but in general found that the fungus is present in soil that may then provide a reservoir for colonisation of the mulch (Bridge & Prior 2007).

The origin of '*Stropharia aurantiaca*' (the woodchip fungus) has been unclear but was suggested by Watling & Gregory (1987) to be Australia, where they consider the native *Psilocybe ceres* to be identical with it. This conclusion was also followed by Daams (1991), and by Grgurinovic (1997). *Psilocybe ceres* is described as slender, glabrous, with elongate stipe, and to occur on soil and rarely on dung (Cleland 1934; Grgurinovic 1997, as *S. aurantiaca*). Pegler (1965), who examined the holotype of *P. ceres*, lodged in K, illustrated the spores and reported the presence of a pseudorhiza (e.g., rhizomorphs) at the stipe base. He also reported the presence of pleurocystidia with refractive inclusions, hence showing that, although the species is described in the protologue as slender, it cannot be identified with *S. thrausta*. The holotype collection comprises sectioned, rather fragmentary fruitbodies not suitable for DNA study. Although given in the protologue as 'testacea', a descriptive note with the specimen reads: 'pileus rufus red, gills watery dirty grey with black tinge turning darker, numerous; stem fibrillose, striate, concolorous towards the base'. Re-examination of this collection by BMS reveals whitish basal rhizoids as well as chrysocystidia and spores identical to those of '*S. aurantiaca*'. Although cheilocystidia could not be recovered, the characters noted, as well as the lower stipe being concolorous with the cap, fully agree with '*S. aurantiaca*' and there seems every reason to accept it as conspecific with that fungus and therefore to provide the earliest name for it. Although '*S. aurantiaca*' has a clear preference for woodchips, a few collections in more natural habitat away from woodchip have been made in England.

A search of the literature has revealed that a later synonym for the species in question is provided by *Nematoloma rubrococcineum* (Balletto 1967). This was described from France 'inter detrito permixta', and agrees well in all respects including spore characters and the possession of chrysocystidia. A coloured plate of the species was published by Nonis (1994) who recombined it as *Hypholoma rubrococcineum*, and another by Mazza (1994) who noted the name as a possible synonym of '*Stropharia aurantiaca*'.

The recent molecular study of the nuclear large ribosomal subunit gene (LSU) of a wide range of agarics by Moncalvo et al. (2002) recognised 117 clades and recovered '*S. aurantiaca*' (as *H. aurantiacum*) in a small clade with sequences from *S. magnivelaris, Leratiomyces similis* and *Weraroa erythrocephala*. This clade was placed in the stropharioid clade group, but was well separated from both *Stropharia* (typified by *S. aeruginosa* (Curtis) Quél.) and *Hypholoma* (typified by *H. fasciculare* (Huds.) P. Kumm.). This indicates that *S. aurantiaca* cannot be placed in the genus *Hypholoma* nor in *Stropharia*, but may belong either in *Leratiomyces* as typified by *L. similis*, or in *Weraroa*. An appropriate genus for *Psilocybe ceres* therefore requires careful consideration based not only on basidiocarp morphology but, especially, on analysis of DNA sequences of this and related taxa. *Weraroa* Singer is a genus of sequestrate agarics popularly known as 'tobacco-pouch fungi'. They have dark spores and coloured pilei and are recognised as close relatives of *Stropharia* (Singer 1960). In Moncalvo et al. (2002), *W. erythrocephala* was recovered with '*H. aurantiacum*' and *L. similis*, and thus *Weraroa* may provide a generic name for '*S. aurantiaca*'. However, *W. virescens* was placed in a different section of their grouping, indicating that *Weraroa* is polyphyletic, and the type species, *W. novae-zelandiae*, was not included in their analysis. In the present study, we report LSU sequence data for some further species, including *W. novae-zelandiae*, and clarify their taxonomy.

Methods

DNA extraction and PCR— The partial LSU sequence of '*S. aurantiaca*' was obtained from material collected at the Royal Horticultural Society Garden, Wisley, UK in 2005 and DNA was extracted as described in Bridge & Prior (2007).

A small section of dried stipe (approx. 2mm^3) of *S. percevalii* (K(M)77890) was disrupted with a micro-homogeniser in a microcentrifuge tube in 300 µl of SDS containing buffer, and DNA was extracted according to Cenis (1992). PCR was undertaken with primers LR6 (Vilgalys & Hester 1990) and LR0R (Moncalvo et al. 1995) with Qiagen "Ready to go beads". PCR conditions were an initial heating to 94°C for 2 min, followed by 30 cycles of 94°C for 2min, 55°C for 1 min, 72°C for 1 min, followed by a final extension of 72°C for 10 min. PCR products for '*S. aurantiaca*' and *S. percevalii* were sequenced by a commercial sequencing service. *Weraroa* and *L. atrovirens* DNA was obtained from portions of recently dried herbarium material (Table 1). DNA was isolated and purified using DNeasy Plant Mini kit (Qiagen, USA). PCR was performed with primers LR5 (Vilgalys & Hester 1990) and LR0R with FastStart Taq (Roche, USA) supplemented with 0.4µg/µl of BSA. PCR conditions were an initial heating to 95°C for 4 min, followed by 19 cycles of 94° C for 1min, 55°C for 30 sec, 72°C for 1 min, followed by 14 cycles of 94°C for 30sec, 60°C for 30sec, 72°C for 1 min, followed by a final extension of 72°C for 15 min. Sequencing of the PCR products was performed with ABI PRISM BigDye Terminator Ready Reaction Kit V3.1 (Applied Biosystems, USA) and run on an Applied Biosystems ABI PRISM 3100 Avant Genetic Analyzer.

Phylogenetic analysis— Our LSU sequences for '*S. aurantiaca*' and *S. percevalii* were compared with representative sequences of the /psychedelia, /hypholoma, /stropharia, /pholiota, /magnivelaris and /psilocybe clades, (clades 106 and 109-113) as recovered by Moncalvo et al. (2002), a sequence for *S. squamosa* (AY207302), as well as sequences for *W. novae-zelandiae, W. erythrocephala* and *W. cucullata* obtained in this study. Sequences were aligned over 882bp (inc. gaps) in CLUSTALW and maximum likelihood trees were constructed in Phylip. Tree construction assumed a transition/transversion ratio of 2 and constant rate variation. A majority rule consensus tree was obtained and this was rooted with *Phlebia uda* (= *Mycoacia uda*).

Results

Our analysis of the LSU sequences (Fig. 1) grouped the reference sequence into the 'genus level' clades described by Moncalvo et al. (2002). The LSU sequences did not contain sufficient variability to be reliably used for species comparisons as is demonstrated by the two sequences from *Weraroa novae-zelandiae* that appear separated within the /psychedelia clade although their sequences only differ by one transition and one transversion. At the generic level the LSU analysis confirms that the red *W. erythrocephala*, together with *W. cucullata*, are closely related to *Leratiomyces similis* and to '*S. aurantiaca*'. However, the type species, *W. novae-zelandiae* (G. Cunn.) Singer, belongs to

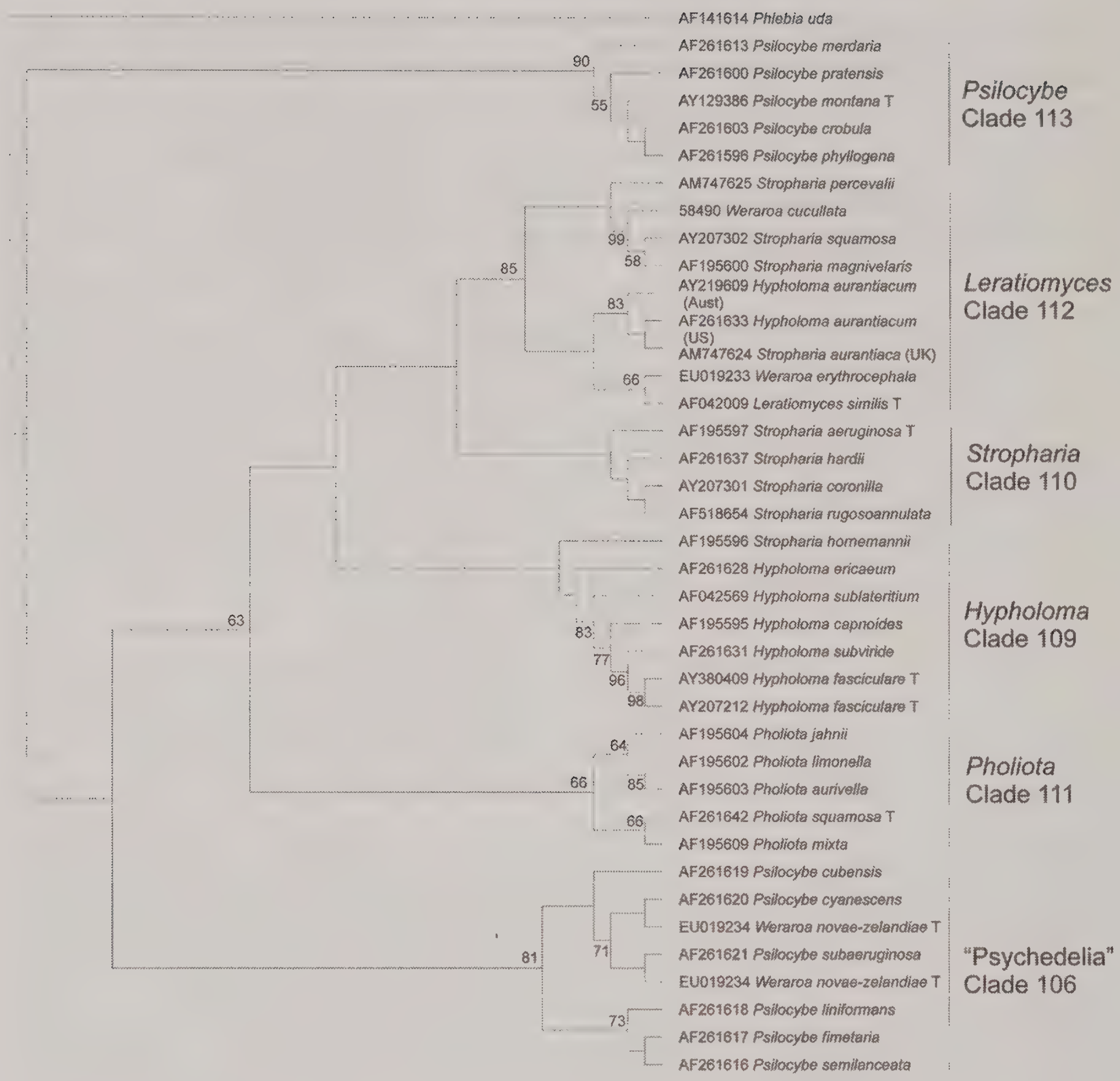
AF141614 Phlebia uda
AF261613 Psilocybe merdaria
AF261600 Psilocybe pratensis
AY129386 Psilocybe montana T
AF261603 Psilocybe crobula
AF261596 Psilocybe phyllogena
AM747625 Stropharia percevalii
58490 Weraroa cucullata
AY207302 Stropharia squamosa
AF195600 Stropharia magnivelaris
AY219609 Hypholoma aurantiacum (Aust)
AF261633 Hypholoma aurantiacum (US)
AM747624 Stropharia aurantiaca (UK)
EU019233 Weraroa erythrocephala
AF042009 Leratiomyces similis T
AF195597 Stropharia aeruginosa T
AF261637 Stropharia hardii
AY207301 Stropharia coronilla
AF518654 Stropharia rugosoannulata
AF195596 Stropharia hornemannii
AF261628 Hypholoma ericaeum
AF042569 Hypholoma sublateritium
AF195595 Hypholoma capnoides
AF261631 Hypholoma subviride
AY380409 Hypholoma fasciculare T
AY207212 Hypholoma fasciculare T
AF195604 Pholiota jahnii
AF195602 Pholiota limonella
AF195603 Pholiota aurivella
AF261642 Pholiota squamosa T
AF195609 Pholiota mixta
AF261619 Psilocybe cubensis
AF261620 Psilocybe cyanescens
EU019234 Weraroa novae-zelandiae T
AF261621 Psilocybe subaeruginosa
EU019234 Weraroa novae-zelandiae T
AF261618 Psilocybe liniformans
AF261617 Psilocybe fimetaria
AF261616 Psilocybe semilanceata
Psilocybe Clade 113
Leratiomyces Clade 112
Stropharia Clade 110
Hypholoma Clade 109
Pholiota Clade 111
"Psychedelia" Clade 106
90
55
99
58
85
83
66
63
83
77
96
98
64
66
85
66
81
71
73

Figure 1. Consensus ML tree of LSU sequences from stropharioid and related taxa. Clade numbers are as given in Moncalvo et al. (2002), numbers at branch points are bootstrap values where greater than 50. T after species indicates type species for genus.

a different clade nesting together with hallucinogenic psilocybin-containing species currently referred to *Psilocybe*, in the /psychedelia clade of Moncalvo et al. *Weraroa* therefore does not offer an appropriate genus for '*S. aurantiaca*'. It could provide an appropriate genus for the /psychedelia clade, but Redhead et al. (2007) propose that *Psilocybe* should be conserved with the circumscription of the /psychedelia clade with *P. semilanceata* as its conserved type. Our study also confirms the close relationship between '*S. aurantiaca*' and *Leratiomyces similis*, a sequestrate species described from New Caledonia. This is the type of *Leratiomyces* that, therefore, is an appropriate genus for '*S. aurantiaca*' and its allies. The sequestrate character of the type and other species so far referred to *Leratiomyces* in itself has little taxonomic value. The inclusion of sequestrate and non-sequestrate species in the same genus is supported by the molecular evidence and has been done recently for other agaricoid fungi, for example in *Cortinarius* (Peintner et al. 2002), and in *Lactarius* and other *Russulaceae* as discussed by Eberhardt & Verbeken (2004).

Hypholoma rubrococcineum has also been referred to the later genus *Stropholoma* (Balletto 1989), typified by *Stropholoma squamosum*, an invalid name. *Stropholoma* was employed by Noordeloos (1999) as a subgenus of *Psilocybe*, to include non-fasciculate species with dry stem, spores longer than 10 µm, and with chrysocystidia either present or absent.

Combinations in *Leratiomyces* for *Psilocybe ceres* as well as other species shown by DNA sequence analysis to be closely related are proposed here. The rather complex nomenclature applied to these fungi is also given. Ironically, the misinterpretation of *Stropharia aurantiaca* has resulted in the most extensive synonymy for the scarcest of the species.

Stropharia squamosa was not included in the Moncalvo et al. (2002) study, but was considered by Walther et al. (2005). Their sequence (AY207302) was recovered within the *Leratiomyces* clade supporting the previously suggested close relationship between *S. squamosa* and '*S. aurantiaca*'. A second sequence available in GenBank also labeled as *S. squamosa* (AF261640) was substantially different from all of the sequences used in this study. It showed 97-99% homology with species of *Coprinus* and *Coprinopsis* and so was not considered further. There are no available LSU sequences for *S. thrausta* and repeated attempts failed to obtain a sequence from our material. We did obtain an ITS sequence from one specimen (K(M)83498) and this gave 90% or higher homology with ITS sequences from '*S. aurantiaca*' and related specimens (results not shown).

Taxonomy

Leratiomyces Bresinsky & Manfr. Binder, Z. Mykol. 64(1): 80 (1998)
≡ *Le Ratia* Pat., Bull. Trimestriel Soc. Mycol. France 23: 52 (1907) (nom. inval., Art. 20.3)
≡ *Le-Ratia* Pat. ex Sacc. & Trotter, Syll. fung. 21: 468 (1912) (nom. illegit., non *Le-Ratia* Broth. & Paris (1909), *Musci*)
= *Nematoloma* sect. *Stropholoma* Singer, Sydowia 2: 36 (1948)
≡ *Stropholoma* (Singer) Balletto, Micol. Ital. 18: 36 (1989) (nom. inval., Art. 33.4)
≡ *Psilocybe* subgen. *Stropholoma* (Singer) Noordel., Persoonia 16: 127 (1995)

Type: *L. similis* (Pat.) Bresinsky & Manfr. Binder, Z. Mykol. 64(1): 80 (1998)
≡ *Le Ratia similis* Pat., Bull. Trimestriel Soc. Mycol. France 23: 52 (1907)

EMENDED DIAGNOSIS — Basidiomata hymenogastroid to agaricoid and velate, pileate, stipitate or rarely almost sessile, usually with basal pseudorhiza, terrestrial or lignicolous; pileus typically subglobose to pyriform, but usually convex to umbonate or acute, moist or viscid, yellow to tawny or red, smooth or with small scales; spores ovate to ellipsoid, with germ pore, pale to dark coloured; chrysocystidia present or absent; clamp connections present.

Four species have been referred to *Le Ratia*, all described from New Caledonia and transferred to *Leratiomyces* by Bresinsky & Binder (1998). They were discussed by Heim (1968). Of these, *L. smaragdinus* (Pat.) Bresinsky & Manfr. Binder and *L. atrovirens* (R. Heim) Bresinsky & Manfr. Binder do not belong in this genus (see 'Excluded species'). *Leratiomyces coccinea* (Massee & Wakef.) Bresinsky & Manfr. Binder has not received further study. As currently understood the genus therefore contains 8 species and is widespread in both tropical and temperate regions. Although typically secotioid, most species now referred there actively discharge their spores. They are variable as noted in the emended diagnosis and it seems that the genus cannot be concisely defined morphologically.

Leratiomyces ceres (Cooke & Massee) Spooner & Bridge, **comb. nov.**
MycoBank MB 511252.

Basionym: *Agaricus ceres* Cooke & Massee, Grevillea 16: 72 (1888)
≡ *Psilocybe ceres* (Cooke & Massee) Sacc., Syll. fung. 9: 140 (1891)

= *Nematoloma rubrococcineum* Balletto, Bull. Trimestriel Soc. Mycol. France 83: 217 (1967)
≡ *Stropholoma rubrococcineum* (Balletto) Balletto, Micol. Ital. 18: 36 (1989) (nom. inval., Arts 33.4, 43.1)
≡ *Hypholoma rubrococcineum* (Balletto) Nonis, Rivista Micol. 37: 109 (1994)

= *Stropharia aurantiaca* [ss auct., misapplied]

Specimen examined: Australia, Melbourne (near), 7 June 1887, J. Reader 35 (holotype)

Selected descriptions and illustrations: Balletto (1967, as *Nematoloma rubrococcineum*), Fuhrer (2005, as *S. aurantiaca*), Orton (1960, as *S. aurantiaca*), Pegler & Legon (1998, as *S. aurantiaca*), Reid (1966, as *S. aurantiaca*), Taylor (1981, as *S. aurantiaca*), Watling & Gregory (1987, as *S. aurantiaca*).

Leratiomyces cucullatus (Shope & Seaver) Beever & D.-C. Park, **comb. nov.**
MycoBank MB 511253.

Basionym: *Bolbitius cucullatus* Shope & Seaver, Mycologia 27: 649 (1935)
≡ *Weraroa cucullata* (Shope & Seaver) Thiers & Watling, Madroño 21(1): 2 (1971)

Selected descriptions and illustrations: Arora (1979, as *Weraroa*), Castellano et al. (1989, as *Weraroa*), Thiers & Watling (1971, as *Weraroa*).

Leratiomyces erythrocephalus (Tul. & C. Tul.) Beever & D.-C. Park, **comb. nov.**
MycoBank MB 511254.

Basionym: *Secotium erythrocephalum* Tul. & C. Tul. [as Tul.], in Raoul, Ann. Sci. Nat., Bot. Sér. 3, 2: 115 (1844)

≡ *Weraroa erythrocephala* (Tul. & C. Tul.) Singer & A.H. Sm., Bull. Torrey Bot. Club 85: 329 (1958)
≡ *Clavogaster erythrocephalus* (Tul. & C. Tul.) Lintott, Cass History & Science: 339 (1977) (nom. inval., Art. 33.4)

Selected descriptions and illustrations: Cunningham (1944, as *Secotium*), Singer & Smith (1958, as *Weraroa*), Soop (2005, as *Weraroa*), Taylor (1981, as *Weraroa*).

Leratiomyces magnivelaris (Peck) Bridge & Spooner, **comb. nov.**
MycoBank MB 511255.
Basionym: *Stropharia magnivelaris* Peck, Harriman Alaska Expedition: 44 (1905)
≡ *Nematoloma magnivelare* (Peck) Singer, Agaricales in Modern Taxonomy, ed. 4: 564 (1986)
≡ *Psilocybe magnivelaris* (Peck) Høil., in Knudsen & Hansen, Nordic J. Bot. 11(4): 481(1991)

Selected descriptions and illustrations: Kytövuori (1990, as *Stropharia*), Noordeloos (1998, 1999, as *Psilocybe*), Watling & Gregory (1987, as *Psilocybe percevalii*)

Leratiomyces percevalii (Berk. & Broome) Bridge & Spooner, **comb. nov.**
MycoBank MB 511257.
Basionym: *Agaricus percevalii* Berk. & Broome, Ann. Mag. Nat. Hist., Ser. 5, 3: 206 (1879)
≡ *Stropharia percevalii* (Berk. & Broome) Sacc., Syll. fung. 5: 1016 (1887)
≡ *Psilocybe percevalii* (Berk. & Broome) P.D. Orton, Notes Roy. Bot. Gard. Edinburgh 29: 80 (1969)

Selected descriptions and illustrations: Kytövuori (1990, as *Stropharia*), Noordeloos (1998, 1999, as *Psilocybe*), Rald (1989, as *Stropharia*)

Leratiomyces squamosus (Pers.) Bridge & Spooner, **comb. nov.**
MycoBank MB 511256.
Basionym: *Agaricus squamosus* Pers., Syn. meth. fung.: 409 (1801)
≡ *Stropharia squamosa* (Pers.) Quél., Mém. Soc. Émul. Montbéliard, 2e Sér., 5: 348 (1873)
≡ *Geophila squamosa* (Pers.) Quél., Enchir. fung.: 111 (1886)
≡ *Nematoloma squamosum* (Pers.) Singer, Sydowia 2: 36 (1948)
≡ *Psilocybe squamosa* (Pers.) P.D. Orton, Notes Roy. Bot. Gard. Edinburgh. 29: 80 (1969)
≡ *Hypholoma squamosum* (Pers.) Urbonas, Lietuvos T.S.R. Mokslu Akad. Darb. C, 4(72): 12 (1975)
≡ *Stropholoma squamosum* (Pers.) Balletto, Micol. Ital. 18: 36 (1989) (nom. inval., Arts 33.4, 43.1)

Selected descriptions and illustrations: Breitenbach & Kränzlin (1995), Guzmán (1983, as *Psilocybe*), Kytövuori (1990, as *Stropharia*), Noordeloos (1999, as *Psilocybe*), Watling & Gregory (1987, as *Psilocybe*).

Leratiomyces squamosus var. ***thraustus*** (Schulzer ex Kalchbr.) Bridge & Spooner, **comb. nov.**

MycoBank MB 511258.

Basionym: *Agaricus thraustus* Schulzer ex Kalchbr., Icon. select. Hymenomyc. Hung.: 30 (1873) & pl. 15 f. 2

≡ *Stropharia thrausta* (Schulzer ex Kalchbr.) Sacc., Syll. fung. 5: 1016 (1887)

≡ *Agaricus squamosus* var. *thraustus* (Schulzer ex Kalchbr.) Cooke, Handb. Brit. fung., ed. 2: 199 (1887)

≡ *Stropharia squamosa* var. *thrausta* (Schulzer ex Kalchbr.) Massee, Brit. fung.-fl. 1: 402 (1892)

≡ *Psilocybe thrausta* (Schulzer ex Kalchbr.) Bon, Bull. Trimestriel Soc. Mycol. France 85(4): Suppl., Atlas Pl. 182 (1970) [1969]

≡ *Hypholoma thraustum* (Schulzer ex Kalchbr.) Urbonas [as '*thrausta*'], Lietuvos T.S.R. Mokslu Akad. Darb. C, 4 (72): 14 (1975)

≡ *Psilocybe squamosa* var. *thrausta* (Schulzer ex Kalchbr.) Guzmán, Nova Hedwigia Beih. 74: 321 (1983)

= *Agaricus thraustus* var. *aurantiacus* Cooke, Ill. Brit. fung. 562 (555) (1885)

≡ *Stropharia percevalii* var. *aurantiaca* (Cooke) Sacc., Syll. fung. 5: 1016 (1887)

≡ *Agaricus squamosus* f. *aurantiacus* (Cooke) Cooke, Handb. Brit. fung., ed. 2: 199 (1887) [some may prefer to interpret this combination as a form of *A. squamosus* var. *thraustus*]

≡ *Stropharia squamosa* var. *aurantiaca* (Cooke) Massee, Brit. fung.-fl. 1: 402 (1892)

≡ *Stropharia aurantiaca* (Cooke) S. Imai, J. Fac. Agric. Hokkaido Imp. Univ. 43: 267 (1938)

≡ *Nematoloma aurantiacum* (Cooke) Guzmán, Nova Hedwigia Beih. 51: 114 (1975) (nom. inval., Art. 33.4)

≡ *Hypholoma aurantiacum* (Cooke) Faus, in Moreno & Faus, Bol. Soc. Micol. Castellana 7: 70 (1982)

≡ *Nematoloma aurantiacum* (Cooke) Guzmán ex Singer, Agaricales in Modern Taxonomy, ed 4 (Koenigstein): 564 (1986)

≡ *Stropholoma aurantiacum* (Cooke) Balletto, Micol. Ital. 18(1): 36 (1989) (nom. inval., Arts 33.4, 43.1)

≡ *Psilocybe aurantiaca* (Cooke) Noordel., Persoonia 16(1): 128 (1995)

Selected descriptions and illustrations: Fortey (2004, as *Psilocybe*), Guzmán (1983, as *Psilocybe*), Imazeki & Hongo (1987, as *Naematoloma squamosum* var. *thraustum*), Noordeloos (1999, as *Psilocybe squamosa* var. *thrausta*).

Excluded species

The LSU sequence available for *Leratiomyces smaragdinus* places it in the /agrocybe clade (clade 80; Moncalvo et al. 2002) and our analysis confirmed this placement. Our analysis of the LSU sequence of *Leratiomyces atrovirens* showed 95-97% homology to a number of species of *Coprinopsis* and *Psathyrella* suggesting that this species should be placed within Moncalvo et al. (2002) /psathyrella clade (clade 89). Walther et al. (2005) recovered an LSU sequence for *Agrocybe pediades* as a sister group to *Stropharia squamosa*. The sequence used in that study (AY207142) differs by some 4% from two other LSU sequences reported for this species (AJ871493 & DQ110872) that are 99% similar to each other. The correct placement of *A. pediades* is unclear.

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Literature cited

Arora D. 1979. Mushrooms Demystified. Berkeley, Ten Speed Press.

Arora D. 1986. Mushrooms Demystified. Ed. 2. Berkeley, Ten Speed Press.

Balletto C. 1967. Une nouvelle espèce du genre *Nematoloma* sensu H. Romagnesi: *Nematoloma rubrococcineum* nov. sp. Bull. Trimestriel Soc. Mycol. France 83, 215–217.

Balletto C. 1989. Problemi di nomenclatura – XV. Micol. Ital. 18(1), 33–37.

Breitenbach J, Kränzlin F. 1995. Fungi of Switzerland. Vol. 4. Lucerne, Mykologia

Bresinsky A, Binder M. 1998. *Leratiomyces* nom. nov. für eine bislang nicht gültig beschreibene Gattung der *Strophariaceae* (*Agaricales*) aus Neukaledonien. *Z. Mykol.* 64, 79 - 82.

Bridge P, Prior C. 2007. Introduction or stimulation? The association of *Stropharia aurantiaca* with bark and wood-chip mulches. European J. Soil Biol. 43, 101–108.

Castellano MA, Trappe JM, Maser Z, Maser C. 1989. Key to Spores of the Genera of Hypogeous Fungi of North Temperate Forests with Special Reference to Animal Mycophagy. Eureka, Mad River Press.

Cenis JL. 1992. Rapid extraction of fungal DNA for PCR amplification. Nucleic Acids Research 20, 2380.

Cleland JB. 1934. Toadstools and Mushrooms and other large fungi of South Australia. Pt. 1. Adelaide.

Cooke MC. 1887. Handbook of British Fungi. Ed. 2. London.

Cunningham GH. 1944. The Gasteromycetes of Australia and New Zealand. Dunedin, McIndoe.

Daams J. 1991. *Stropharia aurantiaca* in Opmars. Coolia 34, 37–44.

Dennis RWG & Wakefield E. 1946. New or Interesting British Fungi. Trans. Brit. Mycol. Soc. 29, 141–166.

Eberhardt U, Verbeken A. 2004. Sequestrate *Lactarius* species from tropical Africa: *L. angiocarpus* sp. nov. and *L. dolichocaulis* comb. nov. Mycol. Res. 108, 1042–1052.

Fortey R. 2004. *Psilocybe aurantiaca* and a case of mistaken identity. Field Mycol. 5, 77–80.

Fuhrer, B. 2005. A Field Guide to Australian Fungi. Melbourne, Bloomings Books.

Grgurinovic CA. 1997. Larger fungi of South Australia. Adelaide, State Government of South Australia

Guzmán G. 1983. The genus *Psilocybe*. *Beih.* Nova Hedwigia 74, 1–439.

Heim, R. 1968. Notes sur la flore mycologique des Terres du Pacifique Sud. VIII. Nouvelles recherches sur les Le Ratia Pat. Rev. Mycol. 33, 137 – 154.

Henrici A. 2001. Notes and Records. Field Mycol. 2, 136–138.

Henrici A. 2006a. Notes and Records. Field Mycol. 7, 101–103.

Henrici A. 2006b. Notes and Records. Field Mycol. 7, 141–142.

Imazeki R, Hongo T. (eds) 1987. Coloured Illustrations of Mushrooms of Japan. Vol 1. Osaka, Hoikusha

Jahnke K-D. 1984. Artabgrenzung durch DNA-Analyse bei einigen Vertretern der *Strophariaceae* (*Basidiomycetes*). Biblioth. Mycol. 96, 1 – 183.

Kytövuori I. 1990. Rantakaulussieni ja kumppanit, *Stropharia squamosa*-ryhmä. Sieni Lehti 44, 97–103.

Mazza R. 1994. I Funghi. Guida al Riconoscimento. Milan

Moncalvo J-M, Wang H-H, Hseu R-S. 1995. Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers and 25S ribosomal DNA sequences. Mycologia 87, 223-238.

Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clemencon H, Miller OK. Jr. 2002. One hundred and seventeen clades of euagarics. Molec. Phylogen. Evol. 23, 357-400.

Nauta M. 2003. A new *Agrocybe* on woodchips in Northwestern Europe. Persoonia 18, 271–274.

Nonis U. 1994. Note micologiche su reperti osservati in esplorazioni personali nel comune di Morsano al Tagliamento (PN). Rivista Micol. 37, 99-112.

Noordeloos ME. 1998. *Pholiota*, *Psilocybe* and *Panaeolus*. Fungi Non Delineati 4, 1–48.

Noordeloos ME. 1999. *Strophariaceae* Sing. & Smith. Pp. 27 – 107. In Bas, C. et al., Flora Agaricina Neerlandica vol. 4. Rotterdam, Balkema.

Orton PD. 1960. New Check List of British Agarics and Boleti. Part III. Notes on genera and species in the list. Trans. Brit. Mycol. Soc. 43, 159–439 (p. 381).

Pegler DN. 1965. Studies on Australian *Agaricales*. Austral. J. Bot. 13, 323–356.

Pegler DN, Legon NW. 1998. *Stropharia aurantiaca*. Profiles of Fungi 97. Mycologist 12, 180.

Peintner U, Moser MM, Vilgalys R. 2002. *Thaxterogaster* is a taxonomic synonym of *Cortinarius*: new combinations and new names. Mycotaxon 81, 177-184.

Rald E. 1989. To for Danmark nye hatsvampe, der volser på traeflos: *Stropharia percevalii* og *Agrocybe putaminum*. Svampe 19, 39–43.

Rea C. (unpublished). Illustrations no. 316.

Redhead SA, Moncalvo J-M, Vilgalys R, Matheny PB, Guzmán-Dávalos L, Guzmán G. 2007. Proposal to conserve the name *Psilocybe* (*Basidiomycota*) with a conserved type. Taxon 56(1): 255 – 257.

Reid DA. 1966. Coloured Icones of Rare and Interesting Fungi. 1: 29, pl. 8. Suppl. Nova Hedwigia XI .

Revett J. 2002. On woodchip fungi. Field Mycol. 3, 72.

Shaw PJA, Kibby G. 2001. Aliens in the flowerbeds. The fungal biodiversity of ornamental woodchips. Field Mycol. 2, 6–11.

Shaw PJA, Butlin J, Kibby G. 2004. Fungi of ornamental woodchips in Surrey. Mycologist 18, 12-15.

Singer R. 1960. Three new species of *Secotiaceae* from Patagonia. Persoonia 1, 385–391.

Singer R, Smith AH. 1958. New or interesting basidiomycetes from the Central Rocky Mountain region. Bull. Torrey Bot. Club 85, 329.

Soop K. 2005. Cortinarioid Fungi of New Zealand. An Iconography and Key. Ed. 4. Soop.

Taylor M. 1981. Mushrooms and Toadstools. Auckland: Reed Books

Thiers HD, Watling R. 1971. Secotiaceous fungi from western United States. Madroño 21, 1–9

Vilgalys R, Hester M. 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. J. Bacteriol. 172, 4238 -4246.

Walther G, Garnica S, Weiss M. 2005. The systematic relevance of conidiogenesis modes in the gilled *Agaricales.* Mycol. Res. 109, 525-544.

Watling R, Gregory NM. 1987. *Strophariaceae* & *Coprinaceae* p.p. British Fungus Flora 5. Royal Botanic Garden, Edinburgh.

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Three new records for the lichen biota of Turkey

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Abstract - Three lichen species, *Cladonia borealis, C. dimorpha,* and *Sphinctrina tubiformis,* are new to the lichen flora of Turkey. For each a short description is presented.

Key words - Trabzon, Giresun

Introduction

Lichenology in Turkey started seriously only in the last two decades. So far a total of 360 papers refer to lichens from Turkey (John 2004). For Trabzon province in the eastern Black Sea region 518 species have been reported (John 1995 and references therein, John 1999, 2000, 2002; John & Breuss 2004, John & Nimis 1998, John et al. 2000, Kınalıoğlu 2007b, Yazıcı 1996, 1999, 2006; Yazıcı & Aslan 2002, 2005) and for Giresun province only 320 species (Aslan & Yazıcı 2006, John & Breuss 2004, Kınalıoğlu 2004, 2005, 2006, 2007a; Kınalıoğlu & Engin 2004, Küçük 1990, Yazıcı & Aslan 2005, 2006). The present paper is a further contribution to the lichen flora of these provinces.

Materials and methods

Samples were collected at three different sites in Trabzon and Giresun provinces between 17 August 2005 and 14 January 2007. They were identified using various floras and identification keys (e.g. Brodo et al. 2001, Goward 1999, Osyczka 2006, Purvis et al. 1992, Wasser & Nevo 2005, Wirth 1995). Specimens are kept in the herbarium of Faculty of Science and Arts, Giresun University, Giresun.

Species recorded

Cladonia borealis S. Stenroos

Primary thallus squamulose, persistent, lobed, 3-5.5 mm across, with a dark yellow or orange tint at the base below. Podetia 2-2.5 cm tall, 4-10 mm across, with rounded areoles to continuously corticate at base, without soredia or granules. Cups goblet-shaped, margins smooth or proliferating. Apothecia bright red, common, on the cup margins. Podetia PD-, K-, C-, KC+ yellow (Brodo et al. 2001, Goward 1999, Osyczka 2006, Wirth 1995).

Grows on soil, humus, mossy rocks or rarely decaying wood in full sun from sea level to the mountain tops. Known from North America, Finland, Gemany, Greenland, Svaldbard (Brodo et al. 2001, Goward 1999, Osyczka 2006, Wirth 1995).

Turkey, Trabzon, Araklı, S of Kızılkaya Yaylası, on soil, 40° 40′ 21″ N, 40° 1′ 24″ E, 2350 m, 17 August 2005, Kınalıoğlu 1445.

C. dimorpha S. Hammer

Primary thallus squamulose, persistent. Podetia green to greyish, 2.7-3.5 cm tall, 2-2.6 mm across. Cup interior containing strongly convex granules or areoles, or both, occasionally also microsquamules, usually inclined, bearing numerous proliferations, these to more than 1 cm tall, in part longitudinally fissured. Apothecia dark brown, on the cup margins. Medulla PD+ orange (Goward 1999).

Grows on soil and mossy rocks in open, coastal localities at lower elevations. Distribution poorly known, reported from western North America and western Eurasia (Goward 1999).

Turkey , Trabzon, Araklı, SE of Paska lar Yaylası, on soil, 40° 40′ 3″ N, 40° 1′ 41″ E, 2400 m, 17 August 2005, Kınalıoğlu 1442.

Sphinctrina tubiformis A. Massal.

Not developing an autonomous thallus. Apothecia 0.16-0.4 mm tall; stalk short to absent, 0-1.2 times as long as wide, dark brown or black; head 0.14-0.36 mm in diam., globose, usually partly broadened vertically and slightly irregular, bright black or dark brown; true exciple dark brown in section, K-. Ascospores 10-15.5 x 5.5-9 µm, broadly ellipsoid, the end pointed, with distinctive surface ornamentation of longitudinally arranged, coarse ridges (Purvis et al. 1992).

Commensalistic to pathogenic on *Pertusaria leioplaca*, occasionally on other *Pertusaria* species. Known from Europe, North, Central & South America, Africa, Asia, Fiji (Purvis et al. 1992).

Turkey , SW of Giresun city centre, on *Pertusaria* sp., 40° 54′ 20″ N, 38° 19′ 24″ E, 5 m, 14 January 2007, Kınalıoğlu 1240.

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Literature cited

Aslan A, Yazıcı K. 2006. Contribution to the lichen flora of Giresun Province of Turkey. Acta Botanica Hungarica 48 (3-4): 231-245.

Brodo MI, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. Yale University Press, New Haven and London.

Goward T. 1999: The Lichens of British Columbia, Illustrated keys, Part 2, Fruticose Species. British Columbia Ministry of Forests.

John V. 1995. Flechten der Türkei IV. Ergänzungen zum die Türkei betreffende lichenologische Schrifttum. Neunkirchener Druckerei und Verlag, Neunkirchen, Germany.

John V. 1999. Lichenes Anatolici Exsiccati. Fasc. 1-3 (No: 1-75). Arnoldia 16: 1-41.

John V. 2000. Lichenes Anatolici Exsiccati. Fasc. 4-5 (No: 76-125). Arnoldia 19: 1-27.

John V. 2002. Lichenes Anatolici Exsiccati. Fasc. 6-7 (No: 126-175). Arnoldia 21: 1-28.

John V. 2004. Lichenological studies in Turkey and their relevance to environmental interpretation.- Abstract book, XI OPTIMA meeting 5.-11.9.2004, Belgrade: 45.

John V, Breuss O. 2004. Flechten der östlichen Schwarzmeer-Region in der Türkei (BLAM-Exkursion 1997). Herzogia 17: 137-156.

John V, Nimis PL. 1998. Lichen flora of Amanos mountain and the province of Hatay. Turkish Journal of Botany 22: 257-267.

John V, Seaward MRD, Beaty JW. 2000. A neglected lichen collection from Turkey: Berkhamsted School Expedition 1971. Turkish Journal of Botany 24: 239-248.

Kınalıoğlu K. 2005. Lichens of Giresun District, Giresun Province, Turkey. Turkish Journal of Botany 29: 1-7.

Kınalıoğlu K. 2006. Lichens of Keşap District (Giresun, Turkey). Acta Botanica Hungarica 48 (1-2): 65-76.

Kınalıoğlu K. 2007a. The Lichen Flora of Kocadağ Mountains and its Environs (Samsun, Turkey). Acta Botanica Hungarica 49 (1-2): 95-104.

Kınalıoğlu K. 2007b. Lichens of the alpine region in Araklı-Sürmene district, Trabzon province (Turkey). Cryptogamie, Mycologie 28 (2): 1-27.

Kınalıoğlu K, Engin A. 2004. Bülbülan (Artvin), Ayder, Anzer (Rize), Kalecik (Trabzon) ve Kümbet (Giresun) Yaylalarının Likenleri. Ot Sistematik Botanik Dergisi Bot. 11 (2): 167-190.

Küçük M. 1990. Giresun Adası'nın Floristik Yapısı. Ormancılık Araştırma Enstitüsü Yayınları 36 (2): 58.

Osyczka P. 2006. The lichen genus *Cladonia* (*Cladoniaceae*, Lichenized *Ascomycota*) from Spitsbergen. Polish Polar Research 27(3): 207-242.

Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The Lichen Flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.

Wasser SP, Nevo E. 2005. Lichen-forming, Lichenicolous, and Allied Fungi of Israel. International Center for Cryptogamic Plants and Fungi, Institute of Evolution, University of Haifa, Israel.

Wirth V. 1995. Die Flechten Baden-Württembergs. Ulmer, Stuttgart.

Yazıcı K. 1996. Altındere Vadisi Milli Parkı Liken Florası. Turkish Journal of Botany 20: 263-265.

Yazıcı K. 1999. Lichen Flora of Trabzon. Turkish Journal of Botany 23: 97-112.

Yazıcı K. 2006. Four new lichen from Turkey. Myxotaxon 95: 315-318.

Yazıcı K, Aslan A. 2002. New records for the lichen flora of Turkey. Turkish Journal of Botany 26: 117-118.

Yazıcı K, Aslan A. 2005. Six new lichen records from Turkey. Myxotaxon 93: 359-363.

MYCOTAXON

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New species of operculate discomycetes (*Ascomycota, Pezizomycetes*) for Israeli mycobiota

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Abstract—Three species from the genera *Helvella* and *Morchella* were recorded for the first time for Israel. Morphological and habitat descriptions, general distribution, illustrations, and taxonomical discussions on *Morchella elata*, *Helvella chinensis* and *H. spadicea* are presented in this paper. Descriptions of all species are provided for Israeli samples.

Key words—Mediterranean, morels, taxonomy, *Pezizales*

Introduction

The study of operculate discomycetes has been neglected in Israel since the publications of Avizohar-Hershenzon & Nemlich (1974, 1978), Binyamini (1972a, b, 1973a, b, 1984, 1986, 1989, 1993, 1994), Nemlich & Avizohar-Hershenzon (1972, 1975, 1976a, b), and Rayss (1940, 1947, 1953). The *Morchella* and *Helvella* species diversity of Israel is poorly known. Only a few surveys of the two genera have been published. The most notable ones include Rayss (1940), Nemlich & Avizohar-Hershenzon (1972), and Binyamini (1984, 1986, 1989). After reviewing regional mycological reports, we found that the following species from the genera *Morchella* and *Helvella* exist in Israel: 2 species of *Morchella* [*M. conica* Pers., *M. esculenta* (L.) Pers.] and 10 species of *Helvella* [*H. acetabulum* (L.) Quél., *H. atra* J. Koenig, *H. crispa* (Scop.) Fr., *H. elastica* Bull., *H. ephippium* Lév., *H. lacunosa* Afzel., *H. leucomelaena* (Pers.) Nannf., *H. pezizoides* Afzel., *H. phlebophora* Sacc., *H. queletii* Bres.].

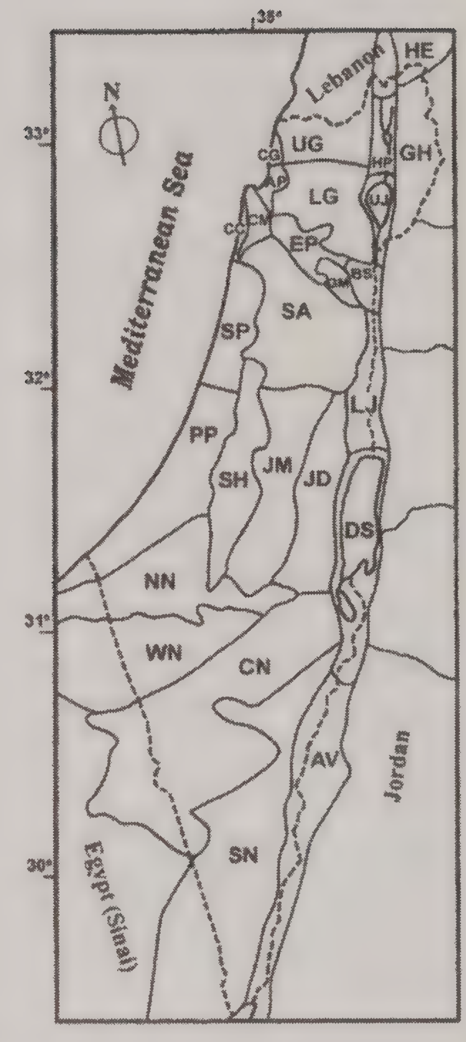


Figure 1: Accepted abbreviations of nature regions of Israel: **AP** – Akko Plain; **AV** – Arava Valley; **BS** – Beit Shean Valley; **CC** – Carmel Coast; **CG** – Coast Galilee; **CM** – Carmel Mount; **CN** – Central Negev; **DS** – Dead Sea Area; **EP** – Esdraelon (Yizre'el) Plain; **GH** – Golan Heights; **GM** – Gilboa Mount; **HE** – Hermon Mount; **HP** – Hula Plain; **JD** – Judean Desert; **JM** – Judean Mts.; **LG** – Lower Galilee; **LJ** – Lower Jordan Valley; **NN** – Northern Negev; **PP** – Philistean Plain; **SA** – Samaria; **SH** – Shefela; **SN** – South Negev; **SP** – Sharon Plain; **UG** – Upper Galilee; **UJ** – Upper Jordan Valley; **WN** – Western Negev.

Materials, methods & results

Collected specimens are preserved in the herbarium of the Institute of Evolution, University of Haifa (HAI, Haifa, Israel). The microscopic characteristics were observed with the Carl Zeiss-amplival microscope. Microscopic photos were taken with a "Sony Camera". The chemical reagent used in the microscopic examination was Melzer's reagent. Fungal material was mounted on a microscope slide and examined in water using a light/dark field microscope with or without phase contrast at ×20, ×40, and ×100 (oil immersion). For statistical calculations, 30-40 ascospores, asci, and paraphyses were measured for every preparation.

Distribution of species is shown (Figure 1) using the natural regions of Israel as described by Feinbrun-Dothan & Danin (1998).

As a result of our investigation, three new species of operculate discomycetes (*Morchella elata, Helvella chinensis,* and *H. spadicea*) have been added to data on Israeli mycobiota. Detailed descriptions, iconography, locations and dates of collections in Israel, habitat and general distribution are given. Taxonomic discussions of mentioned species are presented below.

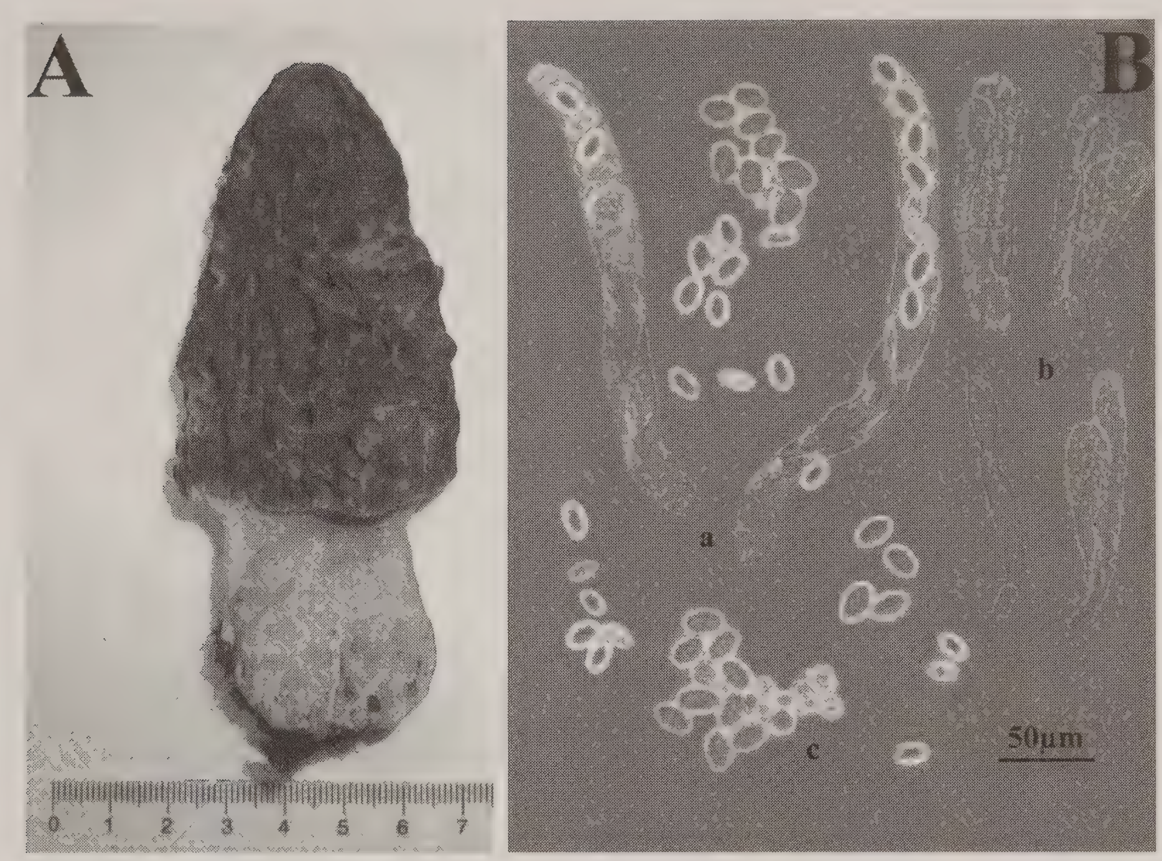


Figure 2. *Morchella elata.*
A – ascocarp; B – microscopic structure: a – asci; b – paraphyses; c – ascospores.

Description and discussion of species

Morchella elata Fr. Syst. Mycol. 2: 8. 1822 **Figure 2**

Icon.: Dennis [1978] 1981: pl. 1B), Breitenbach & Kränzlin (1984: pl. 2).

Macromorphology

Ascocarps 40–150 mm high, 20–50 mm broad, narrowly to broadly conical, occasionally more rounded, obtuse to ovoid-conical; surface of parallel to meandering ridges and cross-ribs, pubescent when young in some forms; color at first greyish to ochre-brown, occasionally pinkish to blackish overall; with age the ridges become dark grey to blackish brown, the pits lighter, ochre to grey-brown; margin when young, overlapping the stipe at attachment, less so in age. Flesh elastic, whitish, thin, firm, brittle, interior, hollow; odor earthy to fungal; taste not investigated. Stipe 20–70 mm high, 10–60 mm thick, hollow, cylindrical, equal to enlarged above and below, the base with longitudinal folds; surface typically whitish to light grey-ochre, pubescent.

Micromorphology

Asci up to 241–286 × 16.1–20.7 µm, 8-spored. Ascospores 18.4–23 × 9.2–16.1 µm, Q = 1.4–2, non amyloid, ellipsoid, smooth, sometimes with small

TABLE 1. Important distinguishing characteristics of *Morchella elata* as cited by different authors

AUTHOR	ASCOCARP HABITUS	ASCI	SPORES	PARAPHYSES
PERSONAL DESCRIPTION	40–150 mm, narrowly to broadly conical, greyish to ochre-brown. Stipe 20–70× 10–60 mm, hollow, whitish to light grey-ochre, base with longitudinal folds	≤241–286 × 16.1–20.7 µm	Ellipsoid, 18.4–23 × 9.2–16.1 µm	Cylindrical or slightly enlarged upwards, 8–17 µm diam
SMICKAYA (1980)	40–100 mm, conical to obtuse, brown or olive-brown. Stipe 40–60× 15–20 mm, hollow, whitish, base bulbous	280–300 × 18–20 µm (cylindrical)	Ellipsoid, 17.5/20–22/25 × 11–15 µm	Cylindrical, enlarged upwards, 300×3 µm
DENNIS [1978] 1981	≤ 100 mm, cylindrical to slightly conical, yellowish brown, dark grey or black. Stipe hollow, white or yellowish, cylindrical	≤ 300 × 20 µm	Ellipsoid, 18–25 × 11–15 µm, (cream-colored)	Cylindrical or slightly enlarged upwards, 8–17 µm diam (multiseptate)
BREITENBACH & KRÄNZLIN (1984)	50–150 mm, conical, honey-brown, red to black-brown. Stipe hollow,ochre, furfuraceous, wrinkled	250–300 × 20 µm	Ellipsoid, 18–25 × 12–16 µm (hyaline)	Septate,branched towards slightly clavate base 17 µm diam
ELLIS & ELLIS [1988] 1998	100 mm, cylindrical to sharply conical. Stipe hollow, white or ochraceous, furfuraceous	———	18–25 × 11–14 µm	———

droplets on both ends (outside the spore wall), spores creamy to pale-tawny in deposit. PARAPHYSES cylindrical or slightly enlarged upwards, hyaline, filiform, multiseptate, and branched toward the base, with slight clavate inflations, 8-17 µm broad.

SPECIMENS EXAMINED. **Israel:** UG, Hanita forest (*Quercus calliprinos*), on the ground, 08. III. 2007; 20. III. 2007, leg. Y. Ur, det. G. Barseghyan (HAI-D-017; D-023; Figure 5).

HABITAT AND DISTRIBUTIÓN: This species is primarily a humus saprotroph, but also can be mycorrhizal (Buscot 1994). The fruiting bodies can appear after fires and are found on soil. EUROPE: UK, Germany, Italy, Norway, Finland, Switzerland, Poland, Czech Republic, Ukraine, Estonia. ASIA: Tajikistan, Kazakhstan, Pakistan, Israel. NORTH AMERICA: USA (California). AUSTRALIA.

DISCUSSION: *Morchella elata* was found in Israel for the first time. It is often confused with old specimens of *M. conica* (Breitenbach & Kränzlin 1984).

Microscopically, all morels are very similar to each other but mostly differ morphologically. *M. elata* is considered by some taxonomists to be synonymous with, or part of a complex of black morel species or subspecies including *M. angusticeps* Peck and *M. conica* (Bunyard et al. 1995, Wipf et al. 1999). The ascomata of *M. elata* are distinguished from other black morels by smooth, ivory-white stalks in younger fruiting bodies, by steel-grey tones in the ridges and pits of the pileus, and by the production of spores larger than those of *M. angusticeps* (Weber 1988). Generally, we can find different descriptions by different authors, which are presented in Table 1.

Helvella chinensis (Velen.) Nannf. & L. Holm,
in Lundell et al., Publ. Herb. Univ. Uppsala 18: 5. 1985 **Figure 3**
≡ *Macropodia chinensis* Velen., Novit. Mycol.: 200. 1940.
=*Octospora villosa* Hedw., Descr. micr.-anal. musc. frond. 2: 54. 1789.
≡ *Helvella villosa* (Hedw.) Dissing & Nannf., Svensk bot. Tidskr. 60: 330. 1966, nom. illegit., non *H. villosa* Schaeff. 1774.
≡ *Helvella dissingii* Korf, Mycotaxon 31(2): 381. 1988.

Icon.: Hedwig (1789: pl. 19 B, as *Octospora villosa*), Dissing & Nannfeldt (1966: pl. 1.3, 2.1, as *Helvella villosa*), Ellis & Ellis [1988]1998: pl. 23. 220, as *H. villosa*).

Macromorphology

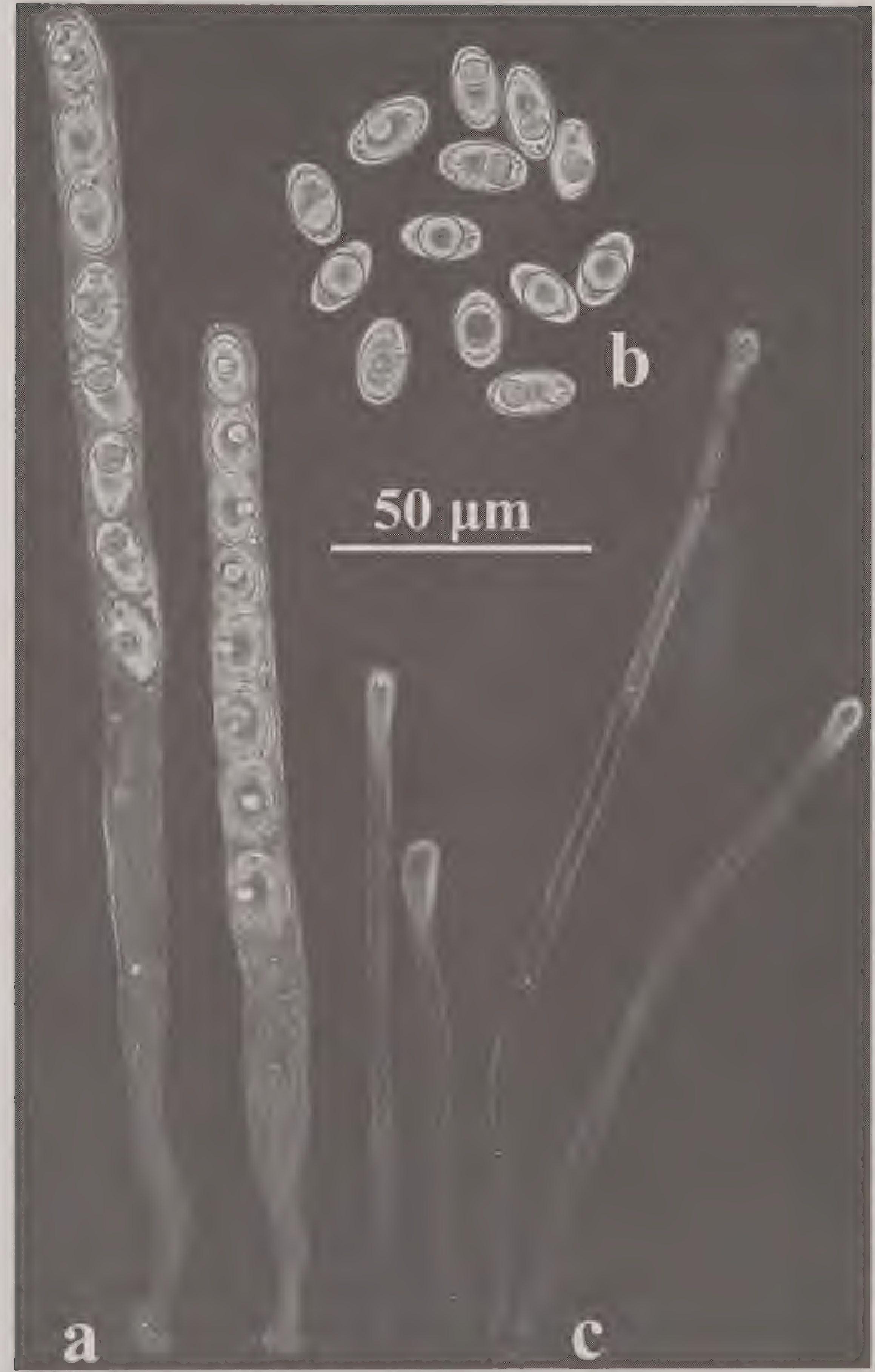
Ascocarps 10–25 mm wide, cup-shaped, compressed when young, becoming saucer-shaped at maturity, splitting into several irregular lobes, exterior pubescent (slightly hairy) to villose; margin sinuous or wavy, bent inward; grey, grayish-brown to steel grey, under side greyish to dark brown to steel grey. Hymenium smooth and dull, dark grey to grey-brown. Flesh whitish, odor and taste indistinct. Stipe 10–15 mm long, cylindrical, solid, downy, thick, same color as underside of cup, becoming whitish or paler at the base.

Micromorphology

Asci cylindrical, attenuated in the base, measure 230–250 × 11.5–13.8 µm, 8-spored. Ascospores 16.1–18.4 × 9.2–11.5 µm, Q = 1.75–1.6, oblong to ellipsoid, with one large and 0 to 5 small oil-droplets, usually smooth. Paraphyses cylindrical, tips with slight clavate in the apex, 4.6–6.9 µm broad. Hyphal outgrowths on the excipulum with oblong cells.

Specimens Examined. Israel: CM, near University of Haifa, on the burnt ground in woods after forest fires in the mountains, *Quercus* and *Pinus* mixed forest. 12.IV.2001, leg. S. Reshetnikov, det. G. Barseghyan (HAI-D-30; Figure 5).

Habitat and distribution: Humus saprotroph; very rare. Edibility not known. On sandy soil in damp woods and along streams under hardwoods, early summer to fall, often after fires. Europe: UK, Switzerland, Germany, Belgium, Italy, Poland, Norway, Czech Republic. Asia: Israel, China, West Pakistan. North America: USA. Australia.


b
50 µm
a
c

Discussion: *Helvella chinensis* is found in Israel for the first time.

Helvella chinensis has been confused with *H. macropus* (Pers.) P. Karst. *H. chinensis* tends to be darker in color and less villose than *H. macropus*. Moreover *H. chinensis* has a greater tendency for the cup to split into irregular lobes at maturity than *H. macropus*. These two similar species not only have macromorphological differences, but we noticed some differences in micromorphology: *H. chinensis* has smaller spore sizes and smoother surfaces, than *H. macropus,* which has more expressed warts exosporial warts. It could also be confused with *H. ephippium* and *H. queletii* (Breitenbach & Kränzlin 1984).

Helvella spadicea Schaeff., Fung. Bavar. Palat. Nasc. 4: 112. 1774 **Figure 4**

=*Helvella leucopus* Pers., Mycol. Eur. 1: 213. 1822.
=*Helvella albipes* Fuckel, Jb. nassau. Ver. Naturk. 23-14: 344. 1870.
=*Helvella heganii* Copel., Ann. Mycol. 2: 510. 1904.

Misapplied: *Helvella monachella* Scop., sensu Quél., Enchir. Fung.: 273. 1886.

Macromorphology

Ascocarps 15–30 mm high, 10–15 broad, saddle-shaped with two lobes, upper surface dark brown to black, under surface whitish to creamy buff, glabrous (smooth), margin curving toward stipe. Flesh thin, elastic, whitish, with insignificant smell and taste. Stipe white to pale cream, terete (round), hollow, equal or tapering toward top, 15–25 mm long, 5–10 mm thick, smooth, flattered or pitted near base.

Micromorphology

Asci are cylindrical, non amyloid, attenuated in the base, measure 300-350 × 18.4-23 μm, 8-spored. Ascospores of 16.1–18.4 × 9.2–11.5 μm, ellipsoid, hyaline, smooth, with large central oil-drop, and with many small oil drops around large drop. Paraphyses of 230-250 × 4.6-6 μm cylindrical, slender, septate, forked, and clavate in the apex.

Specimens Examined. Israel: UG, Park Goran, on the ground in *Quercus calliprinos* frorest, 9.II.2007, leg. A. Rotenberg, det. G. Barseghyan (HAI-D-32; Figure 5).

Habitat and distribution: Humus saprotroph; very rare. Inedible. Europe: UK, Germany, Austria, France, Italy, Belgium, the Netherlands, Czech Republic, Romania, Hungary, Portugal. Asia: Israel, Turkey, Kyrgyzstan. North America: USA. Africa: Algeria.

Discussion: *Helvella spadicea* was found in Israel for the first time. Classical species very easy to identify by its dark coloration of two-lobed, saddle-shaped

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Figure 3. Microscopic structure of *Helvella chinensis*: a – asci with eight smooth ascospores; b – ascospores with oil-drops; c – paraphyses with slightly inflated in the apex.

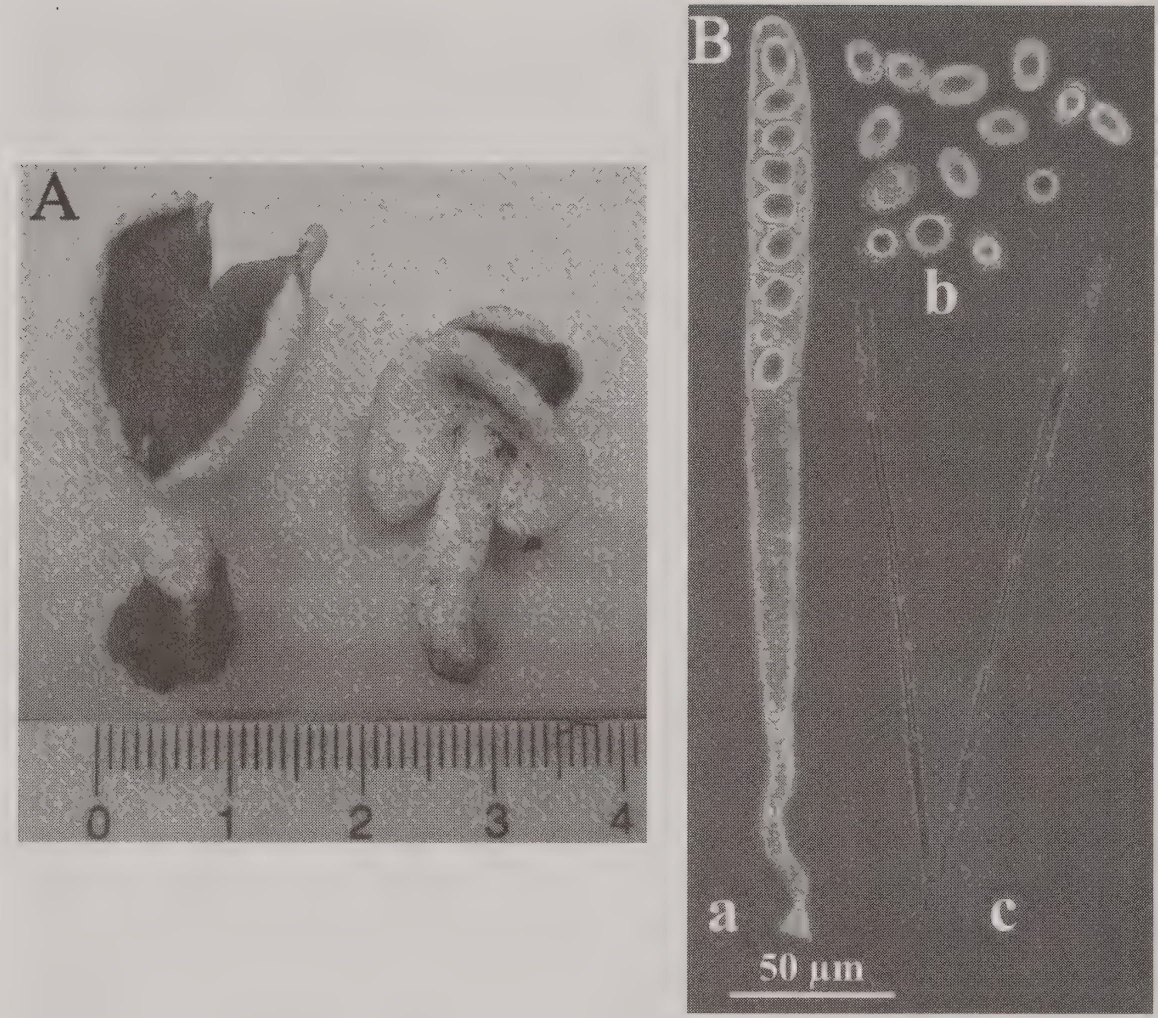

Figure 4. *Helvella spadicea.*
A – ascocarps; B – microscopic structure: a – asci with eight smooth ascospores; b – ascospores with oil-drops; c – paraphyses forked and inflated in the apex.

ascocarp with smooth, white, cylindrical stipe. It is different from other species of genus *Helvella,* but it can be confused with *H. lacunosa* and *H. fusca* Gillet. The last ones have deep furrows. Ascomata of *H. lacunosa* have the same coloration as *H. spadicea,* but stipe greyish and furrowed. Ascomata of *H. fusca* have dark brown or black coloration, with a little reddish tint, stipe white, deeply furrowed.

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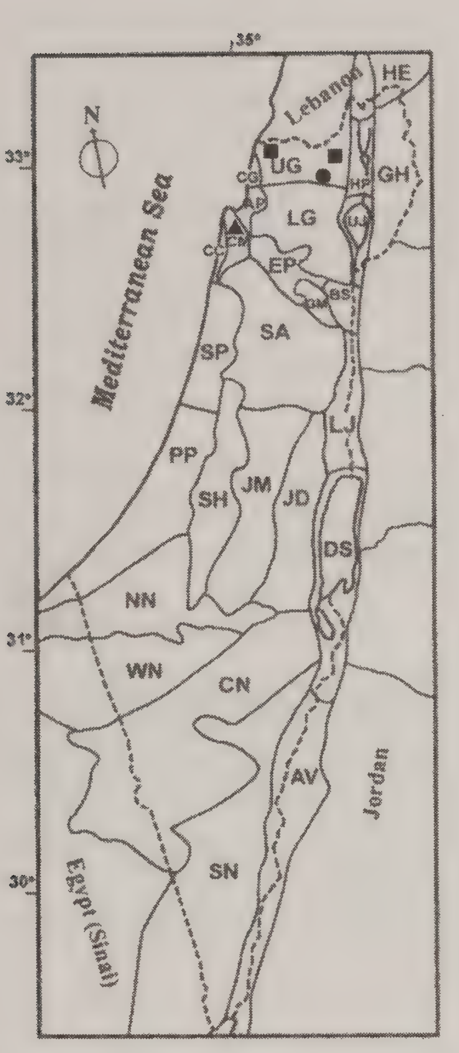

Figure 5. Distribution of *Morchella elata*, *Helvella chinensis* and *H. spadicea* in Israel.

■ — *Morchella elata*

▲ — *Helvella chinensis*

● — *Helvella spadicea*

Literature cited

Avizohar-Hershenzon Z, Nemlich H. 1974. *Pezizales* of Israel II. *Pezizaceae*. Isr. J. Bot. 23: 151-163.

Avizohar-Hershenzon Z, Nemlich H. 1978. *Pezizales* of Israel VI. Addition to *Humariaceae*. Isr. J. Bot. 27: 18-23.

Binyamini N. 1972a. *Trichophaea abundans* (Karst.) Boud. *Antracobia humillima* Malencon. Svensk Bot. Tidskr. 67: 154-158.

Binyamini N. 1972b. Some coprophilous fungi of Israel. I. *Ascomycetes*. Isr. J. Bot. 23: 112-116.

Binyamini N. 1973a. Coprophilous fungi of Israel. II. Isr. J. Bot. 22: 151-158.

Binyamini N. 1973b. Coprophilous fungi of Israel. III. Isr. J. Bot. 22: 159-165.

Binyamini N. 1984. Larger fungi of Israel. *Ascomycotina*, *Basidiomycotina*. (*Aphyllophorales*, *Auriculariales*, *Tremellales* and *Gasteromycetes*). Ramot Publishing Co: Tel Aviv (Israel). 175 pp.

Binyamini N. 1986. *Pezizales* and ligninocolous *Ascomycotina* fungi from Israel I. Trans. Mycol. Soc. Japan 27: 441-450.

Binyamini N. 1989. Rare and interesting records of the higher fungal flora of Israel. IV Opera Bot. 100: 23-27.

Binyamini N. 1993. Lignicolous *Ascomycotina* fungi from Israel III. Trans. Mycol. Soc. Japan 34: 159-162.

Binyamini N. 1994. New records of higher fungi from Israel. Mycoscience 35: 425-428.

Breitenbach J, Kränzlin F. 1984. Fungi of Switzerland. Vol. 1. *Ascomycetes*. Verlag Mykologia: Lucerne (Switzerland). 310 pp.

Bunyard B, Nicholson M, Royse D. 1995. Phylogenetic resolution of *Morchella, Verpa*, and *Disciotis* [*Pezizales*: *Morchellaceae*] based on restriction enzyme analysis of the 28S ribosomal RNA gene. Exp. Mycol. 19: 223-233.

Buscot F. 1994. Ectomycorrhizal types and endobacteria associated with ectomycorrhizas of *Morchella elata* (Fr.) Boudier with *Picea abies* (L.) Karst. Mycorrhiza 4: 223-232.

Dennis R. 1981. [First published 1978]. British *Ascomycetes*. A.R. Gantner Verlag K.G.: Vaduz (Liechtenstein). 585 pp.

Dissing H, Nannfeldt J. 1966. *Helvella cupuliformis* sp. nov., *H. villosa* (Hedw. ex O. Kuntze) comb. nov., *H. macropus* (Pers. ex Fr.) Karst., and their allies. Svensk Bot. Tidskr. 60: 325-337.

Ellis M, Ellis P. 1998. [First published 1988] Microfungi on miscellaneous substrates. The Richmond Publishing Co. Ltd: Slough (England). 246 pp.

Feinbrun-Dothan N, Danin A. 1998. Analytical Flora of Eretz-Israel. 2nd edn. Publishing House CANA: Tel Aviv (Israel). 1008 pp.

Hedwig J. 1789. Descriptio et adumbratio microscopico-analytica muscorum frondosorum. Descr. 2: 1-112, pl. 1-40.

Nemlich H, Avizohar-Hershenzon Z. 1972. *Pezizales* of Israel. I. *Morchellaceae* and *Helvellaceae*. Isr. J. Bot. 21: 153-163.

Nemlich H, Avizohar-Hershenzon Z. 1975. *Pezizales* of Israel. III. *Humariaceae* (A). Isr. J. Bot. 24: 190-197.

Nemlich H, Avizohar-Hershenzon Z. 1976a. *Pezizales* of Israel. IV. *Humariaceae* (B). Isr. J. Bot. 25: 41-52.

Nemlich H, Avizihar-Hershenzon Z. 1976b. *Pezizales* of Israel. V. *Ascobolaceae* and *Sarcoscyphaceae*. Isr. J. Bot. 25: 53-61.

Rayss T. 1940. Nouvelle contribution á l'étude de la mycoflora de Palestine. Palest. J. Bot. 1: 313-355.

Rayss T. 1947. Nouvelle contribution á l'étude de la Mycoflora de Palestine (4e partie). Palest. J. Bot. 4: 59-76.

Rayss T. 1953. Nouvelle contribution á l'étude de la Mycoflora de Palestine (6e partie). Palest. J. Bot. 6: 37-46.

Smickaya M. 1980. *Operculate Discomycetes*. Mycoflora of Ukraine. Naukova Dumka Press: Kiev (Ukraine). 223 pp.

Weber N. 1988. A morel hunter's companion: a guide to the true and false morels of Michigan. MI, Two Peninsula Press: Lansing (USA). 209 pp.

Wipf D, Fribourg A, Munch J, Botton B, Buscot F. 1999. Diversity of the internal transcribed spacer of rDNA in morels. Can. J. Bot. 45: 769-778.

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Type studies on South American *Strophariaceae*: 1. *Pholiota varzeae* from the Brazilian Amazon

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Abstract — The study of the holotype of *Pholiota varzeae* revealed the presence of numerous acanthocytes in its rhizomorphs, generally accepted as an exclusive generic character of the genus *Stropharia*. The proposed new combination, *S. varzeae*, is based in morphological and anatomical characters. The taxonomic discussion is accompanied by detailed macroscopic and microscopic descriptions and illustrations.

Key words — *Agaricales*, *Pholiota* section *Albivelatae*, Amazon mycobiota, várzea vegetation, nomenclature

As part of ongoing studies on the genus *Stropharia* (Fr.) Quél. (*Strophariaceae*, *Agaricales*) in south Brazil (Cortez & Silveira 2008), the type specimens of some South American taxa were studied. In this work, the holotype collection of *Pholiota varzeae*, collected from the Brazilian Amazon and described by Singer (1989), is detailed and discussed and its transference to the genus *Stropharia* is proposed.

Materials and methods

The holotype collection of *Pholiota varzeae*, on loan from Chicago's Field Museum (F), was examined. Thin sections of the dried basidiomes were mounted in 5% KOH and 1% Congo Red solutions and examined microscopically. A minimum of 25 measurements were taken for all microstructures and microdrawings were made assisted by a light tube. For basidiospores, Q represents the ratio of length width, Q_m the mean value of Q, and n the number of measured basidiospores. The macroscopic description (including Maerz & Paul (1930) color codes, shown here in quotation marks) is adapted from the original Latin diagnosis (Singer 1989).

Taxonomy

Stropharia varzeae (Singer) Cortez, **comb. nov.** FIGS. 1-7

MYCOBANK MB 511191

BASONYM: *Pholiota varzeae* Singer, Fieldiana, Bot. 21: 113, 1989.

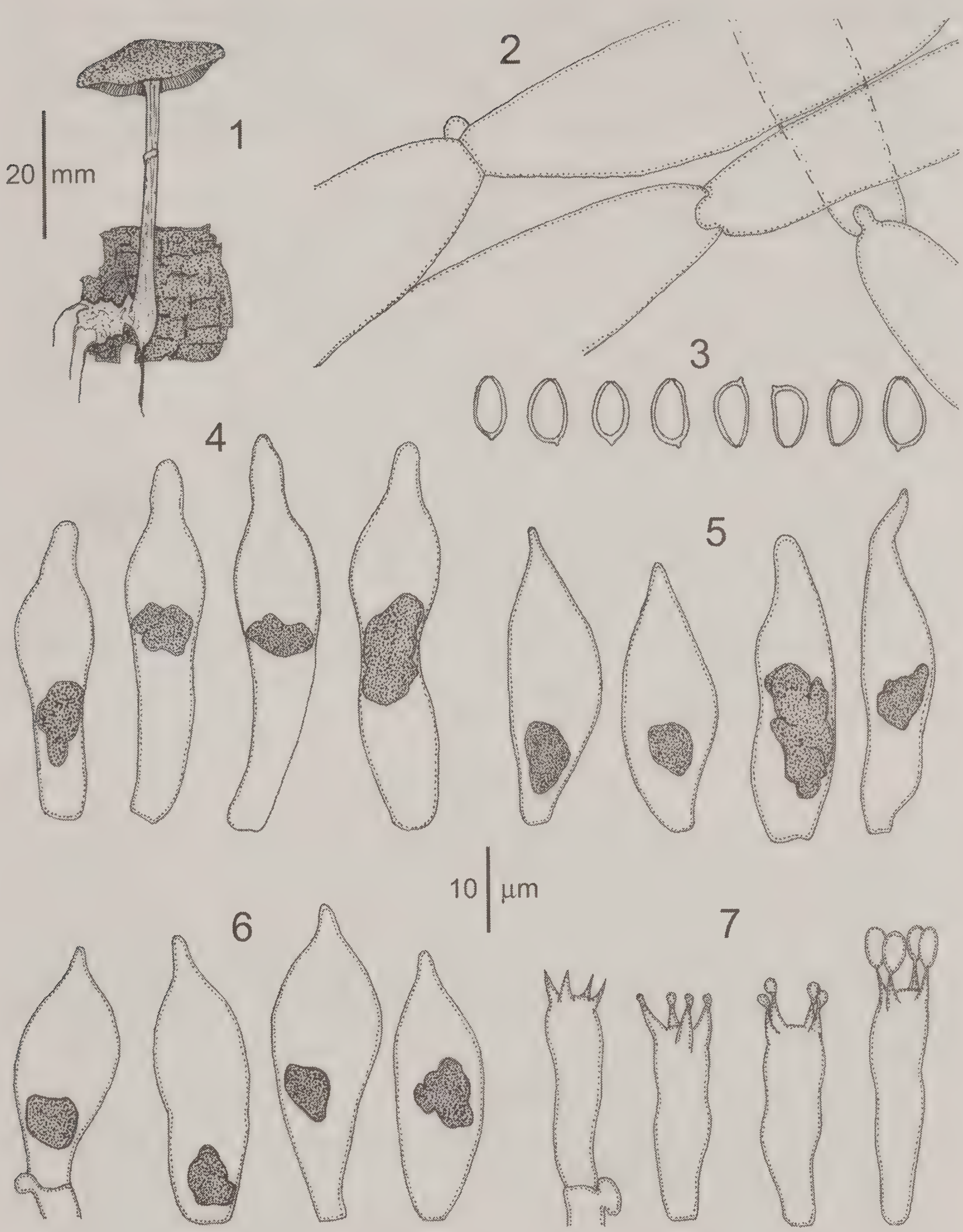
PILEUS 21–30 mm diam, convex and umbonate to subumbonate to finally depressed; rusty ("henna") with the disc reddish-brown ("mascara" to "Maracaibo"), surface dry; context whitish. LAMELLAE adnate, close, brownish ("Cuban sand", "atmosphere" to "kis kilim"), with a conspicuous whitish margin. STIPE 22–46 × 2.5–7.5 mm, central, cylindrical or with a slightly attenuate apex and expanded base; cream to grayish colored, with longitudinal dark brown fibrils; abundant white rhizomorphs and basal mycelium abundant at the base. VEIL forming a membranous, slightly grooved and whitish annulus. SPORE PRINT "falcon".

BASIDIOSPORES 6–7.5(–8) × 4–4.5(–5) μm, Q= 1.50–1.75(–1.80), Q_m= 1.65, n= 30, subellipsoid to ovoid in both face- and side-view, some slightly reniform in profile, smooth and thick-walled, with a reduced germ-pore; yellowish brown in KOH. BASIDIA 20–27 × 6–7.5 μm, clavate, 4-spored. PLEUROCYSTIDIA 35–46 × 9.5–13 μm, as chrysocystidia, fusoid or subclavate, with obtuse to rounded apex, thin-walled, with yellowish to greenish contents. CHEILOCYSTIDIA (24–)29–38 × (8–)10–13 μm, as chrysocystidia, fusoid to clavate, with a mucronate apex, similar to pleurocystidia, but slightly smaller; thin-walled, with yellowish to greenish contents. PILEIPELLIS a trichodermium, hyphae inflated to subcylindrical, clamped, smooth and thin-walled, hyaline, 11–17(–21) μm diam. CONTEXT formed of interwoven, hyaline, thin-walled, and clamped hyphae, 8–16 μm diam. GILL TRAMA regular, composed of hyaline, thin-walled, cylindrical to inflated hyphae, 6–9(–11) μm diam. STIPITIPELLIS composed of hyaline, non-gelatinized, filamentous, smooth and thin-walled hyphae, 4–6.5 μm diam. CAULOCYSTIDIA 29–47 × 9–12 μm, as chrysocystidia, mainly clavate or some fusoid, similar to the pleurocystidia, abundant on the stipe apex. ACANTHOCYTES numerous, observed only on rhizomorphs' surface. CLAMP CONNECTIONS present.

HABITAT: gregarious on decayed palm and dicotyledonous wood in tropical flooded forest ("várzea" vegetation).

EXAMINED SPECIMEN: BRAZIL. Amazonas: Paraná do Januacá, near to Santa Luzia, Lago do Castanho, in "várzea" vegetation, 23.V.1980, *Singer B 12177* (F 1030768 – holotype).

REMARKS: The membranous annulus, the presence of chrysocystidia as pleuro-, cheilo- and caulocystidia, and especially the presence of acanthocytes in the type specimens of *Pholiota varzeae* support its transfer to *Stropharia*. Singer (1989) included *P. varzeae* in *Pholiota* section *Albivelatae* A.H. Sm. & Hesler; most species of this section have been assigned to *Stropharia* due the presence of acanthocytes (cf. Norvell & Redhead 2000), an exclusive feature of this genus



Figs. 1-7. *Stropharia varzeae* (Holotype, F 1030768)
1. Basidiome. 2. Hyphae of the pileipellis. 3. Basidiospores.
4. Pleurocystidia. 5. Caulocystidia. 6. Cheilocystidia. 7. Basidia.

(Farr 1980). An additional distinguishing feature of the species is its habitat in "várzea" vegetation, growing on palm and wood debris (Singer 1989).

Except for only minor differences between the basidiospore size ranges described by Singer (1989) and those reported here, the measurements of the basidia, cystidia, and pileipellis hyphae in the type were slightly larger than those presented by Singer (1989). Singer also did not report cheilocystidia in this species, considering them "*veris haud differentiatis*". Cheilocystidia as well as pleuro- and caulocystidia were checked in the type specimens and we consider it as chrysocystidia.

Singer (1989) related his *Pholiota varzeae* to *P. cubensis* Earle, another species occurring in Brazil (Pegler 1997, Cortez & Silveira 2008). The latter species differs mainly by its more robust habit and absence of chrysocystidia on gill edge and stipitipellis. Norvell & Redhead (2000) recently transferred *P. cubensis* to *Stropharia*, renaming it *S. earlei* Norvell & Redhead. Another similar taxon in *Pholiota* section *Albivelatae* is *P. apiahyna* Speg., which differs from *S. varzeae* by the fusoid to clavate and mucronate pleurocystidia and the non-chrysocystidioid cheilocystidia.

Based on all above-cited features and following the criterion of the presence of acanthocytes as a synapomorphic feature of *Stropharia*, *P. varzeae* is considered here as an authentic member of this genus and thus the above new combination is proposed. *Stropharia* has proved to be a more diverse than previously documented in Brazil. To determine if *S. varzeae* is in fact restricted to the "várzea" vegetation, as Singer (1984, 1989) stated, will deserve future mycological investigations in Amazon region.

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The author thanks the kindness of the herbarium F (Field Museum, Chicago) for allowing the study of some Singer's South American collections. Special thanks to Dr. Victor M. Bandala (Instituto de Ecologia, Mexico) and Dr. Lorelei Norvell (Pacific Northwest Mycology Service and Mycotaxon Editor–In–Chief, USA) for critical review of the manuscript and editorial assistance, and Dr. Shaun Pennycook (Mycotaxon Nomenclature Editor) for nomenclatural advice. CNPq (Brazil) is acknowledged for financial support.

Literature cited

Cortez VG, Silveira RMB. 2008. The agaric genus *Stropharia* (*Strophariaceae*) from Rio Grande do Sul State, Brazil. Fungal Diversity: in press.

Farr DF. 1980. The acanthocyte, a unique cell type in *Stropharia* (*Agaricales*). Mycotaxon 11: 241-249.

Maerz A, Paul MR. 1930. A Dictionary of Color. New York (USA): McGraw-Hill, 207pp.

Norvell LL, Redhead SA. 2000. *Stropharia albivelata* and its basionym *Pholiota albivelata*. Mycotaxon 76: 315-320.

Pegler DN. 1997. The agarics of São Paulo, Brazil. London (UK): HMSO/Royal Botanic Gardens, Kew, 68pp.

Singer R. 1984. Adaptation of higher fungi to várzea conditions. Amazoniana 8: 311-319.

Singer R. 1989. New taxa and new combinations in the *Agaricales* (Diagnoses Fungorum Novorum Agaricalium IV). Fieldiana Bot. 21: 1-133.

MYCOTAXON

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Lichens from the Batman, Mardin, Osmaniye, and Sivas regions of Turkey

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Abstract — A total of 205 lichen taxa (198 species, 2 subspecies, 4 varieties, 1 forma) and one lichenicolous fungus were identified from 25 different localities in the Batman, Mardin, Osmaniye and Sivas regions of Turkey. *Cladonia metacorallifera, Caloplaca flavocitrina, Caloplaca variabilis* f. *ocellulata, Phaeophyscia chloantha* and *Usnea wasmuthii* are new to Turkey. 130 species and one lichenicolous fungus (*Lichenodiplis lecanorae*) are new records from Osmaniye. Moreover, 50 taxa are reported as new from Mardin, 35 from Sivas, and 23 from Batman. Distribution and substrata are summarized for the complete annotated species list posted at http://www.mycotaxon.com/resources/weblists.html

Keywords — *Ascomycetes*, flora, biota

Introduction

Compared to other countries, not many lichen studies have been conducted in Turkey previous to this decade, so that the lichen biota of Turkey remains poorly known. Recently, however, there has been a substantial increase in the number of lichenological papers for Turkey (Halıcı & Aksoy 2006, Yazıcı 2006, Yazıcı & Aslan 2007, Yazıcı & Aptroot 2007). Although previous lichenological

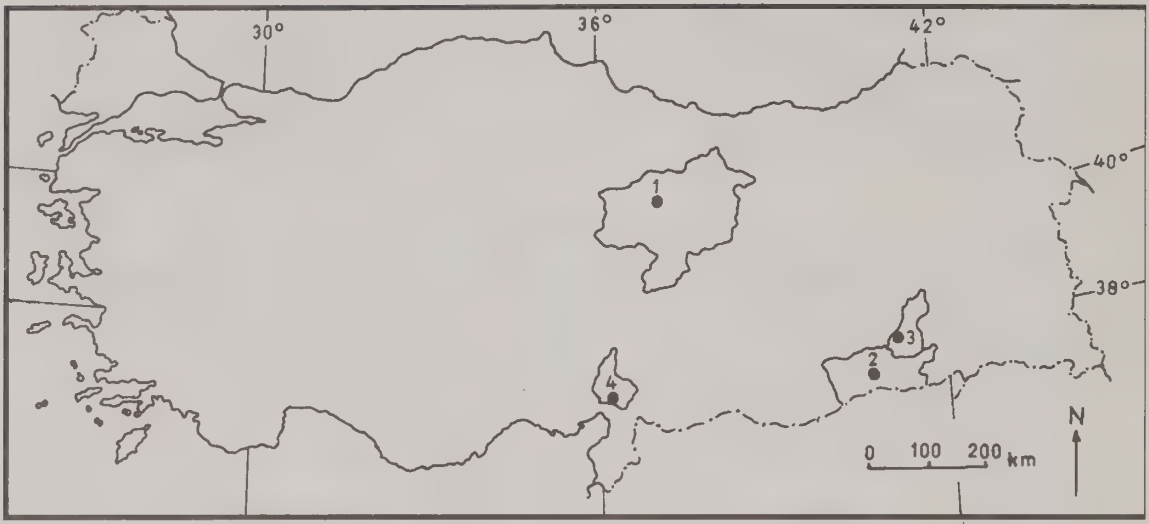

Figure 1. Map of the study area showing the four provinces dealed with in this paper.
1: Sivas, 2: Mardin, 3: Batman, 4: Osmaniye

research (John 2002, John & Türk 2006, John et al. 2000, Hafellner & John 2006, Nimis & John 1998, Steiner (1921) has been reported for Batman, Osmaniye and Sivas, no lichen records have thus far been reported for Mardin (Midyat). Additionally, several regions in Batman, Osmaniye, and Sivas remain still unexplored. This present paper provides information on the lichen biota in the above regions of Turkey.

Sivas and Batman have continental climates. Steppe vegetation is dominant in plateaux and hills. Temperatures range from a winter low of –34.6 °C to a summer high of 38.3 °C. The mean annual humidity is 80.0%. Mean annual rainfall is 420 mm (Akman 1990).

Osmaniye has a typical mediterranean climate. Forest and shrub fields are quite large (42%). Lowlands are seen culture plants, macchia between 500–600 m and coniferous trees in upper fields (Baytop et al. 1963).

Mardin (Midyat) is influenced by both mediterranean and continental climates. The fields are mostly uneven in Mardin and mountains are not very hgh. *Quercus* communities grow in high fields of the mountains (Baytop et al. 1963). The highest precipitation is 115.8 mm in March. The lowest temperature is –2.6 °C in February while the highest 42.5 °C in July (Akman 1990).

Batman forests are composed of *Quercus*, *Juglans*, *Populus*, *Platanus*, *Pistacia*, *Pyrus* and *Prunus* (Baytop et al. 1963). The summer mean temperature is 28 °C, and the winter mean is 3.9 °C in winters. Mean annual precipitation is 713.4 mm (Akman 1990).

Material and methods

Specimens were collected from 25 different areas between 15 August 2006 and 09 February 2007. The study areas are randomly distributed in four provinces of Turkey: Batman, Mardin, Osmaniye and Sivas. Lichen samples were dried at room temperature and studied using stereo and compound light microscopes. Secondary metabolites were identified by spot test (Giralt 2001, Halonen et al. 1988, Mayrhofer 1988, Poelt 1974, Purvis et al. 1992, Wirth 1995). All specimens studied were deposited in the herbarium of the Biology Department, Faculty of Sciences and Arts, Karadeniz Technical University.

Results

The taxonomic survey of Batman, Mardin, Osmaniye and Sivas yielded 205 lichen taxa (198 species, 2 subspecies, 4 varieties, 1 forma) representing 70 genera in 31 families in the *Ascomycota*. Additionally, one lichenicolous fungus was identified. Of these, 146 taxa were collected in Osmaniye, 50 in Mardin, 39 in Sivas, and 24 in Batman. New records per province include 130 lichens and the lichenicolous fungus *Lichenodiplis lecanorae* for Osmaniye, 50 lichens for Mardin, 35 lichens for Sivas, and 23 lichens for Batman.

Discussion

Caloplaca flavocitrina, *Caloplaca variabilis* f. *ocellulata*, *Cladonia metacorallifera*, *Phaeophyscia chloantha* and *Usnea wasmuthii* are new records for Turkey.

Of the 205 taxa, 111 are crustose, 56 foliose, 26 fruticose, and 2 leprose. Further, 86 taxa were epiphytic, 88 saxicolous, eight terricolous, 4 epiphytic or saxicolous, 5 epiphytic or terricolous, and 3 terricolous or saxicolous. Substrates were varied, with 5 taxa growing on decayed barks, 9 on mosses, 10 on limestone, 21 on conifereous trees, and 29 on deciduous trees.

Caloplaca, *Cladonia*, *Lecanora*, *Rinodina*, *Verrucaria* and *Physcia* are the common genera in the area researched. Among the common genera, *Caloplaca* is the most diverse (represented by 17 species), with 17 taxa occurring in Mardin and 9 in Sivas. The members of the genus *Cladonia* were only found in Osmaniye. Foliose genera such as *Xanthoria*, *Phaeophyscia*, *Physcia*, *Melanelia*, *Parmelia*, *Melanelixia*, *Melanohalea*, were mostly found in Osmaniye and Sivas regions on mostly deciduous trees i.e. *Carpinus*, *Prunus*, *Pyrus*, *Quercus*, and *Salix*. Saxicolous crustose lichens were found in all the stations and are very common, especially in Osmaniye (Büyük Kuyucak district), Osmaniye (Center); Zorkun high plateau (Sarıüce District), Sivas (İşhanı village), Sivas (Center); Mardin (Midyat); Acırlı village and Batman (Arıca village).

Aspicilia calcarea, *Verrucaria dufourii*, *V. calciseda* and *V. muralis*, which are determined as indicator species of lime and calcareous substratum, was found only in Osmaniye: Sarıüce, Yoncalı, Mardin: Midyat, Acırlı village and Batman: Arıca, which are situated near a lime pit.

Species considered sensitive by Purvis et al. (1992) and Wirth (1995), including *Usnea*, *Ramalina farinacea*, *R. calicaris*, *R. fraxinea*, *Physcia aipolia*, *Lobaria pulmonaria, Pertusaria pertusa, P. amara* and *P. coccodes,* were found in the study area, especially in Osmaniye.

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Literature cited

Akman Y. 1990: İklim ve Biyoiklim (Biyoiklim Metodları ve Türkiye İklimleri). PalmeYayın Dağıtım. PalmeYayınları. Mühendislik Serisi: 103, 1.Basım. Kasım. Ankara.

Baytop A, Denizci R. 1963: Türkiye'nin Flora ve Vejetasyonuna Genel Bir Bakış. Ege Üniv. Fen Fak. Monografiler Ser. 1, Ege Üniv. Mat., İzmir.

Giralt M. 2001: The lichen genera *Rinodina* und *Rinodinella* (lichenized Ascomycetes, *Physciaceae*) in the Iberian Peninsula. Biblioth. Lichenol. 79: 1–160.

Hafellner J, John V. 2006: Über Funde lichenicoler nicht-lichenisierter Pilze in der Türkei, mit einer Synopsis der bisher im Land nachgewiesenen Taxa. Herzogia 19: 155–176.

Halıcı MG, Aksoy A. 2006: Saxicolous and terricolous lichens of Şirvan Mountain (Pınarbaşı, Kayseri). Tr. J. Bot. 30: 477–481.

Halonen P, Clerc P, Brodo IM, Wulf K. 1988: Synopsis of the genus *Usnea* (lichenized *Ascomycetes*) in British Columbia, Canada. The Bryologist 101: 36–40.

John V, Seaward MRD, Beatty JW. 2000: A neglected lichen collection from Turkey: Berkhamsted School Expedition 1971. Turk J Bot. 24: 239–248.

John V. 2002: Lichenes Anatolici Exsiccati. Arnoldia. 6–7: 126–175.

John V, Türk A. 2006: Species/area curves for lichens on gypsum in Turkey. Mycologia Balcanica 3: 55–60.

Mayrhofer M. 1988: Studien über die saxicolen Arten der Flechtengattung *Lecania* in Europa II. *Lecania* s.str. Biblioth. Lichenol. 28: 1–133.

Nimis PL, John V. 1998: A contribution to the lichen flora of Mediterranean Turkey. Cryptogamie Bryol. Lichénol. 19: 35–58.

Poelt J. 1974: Bestimmungsschlüssel europäischer Flechten. J.Cramer, Lehre.

Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992: The lichen flora of Great Britain and Ireland. Natural History Museum Publications & The British Lichen Society, London.

Steiner J. 1921: Lichenes aus Mesopotamien und Kurdistan sowie Syrien und Prinkipo. Annalen Naturhist Mus. Wien 34: 1–68.

Wirth V. 1995: Die Flechten-Baden Württembergs. Teil 1–2. Ulmer, Stuttgart.

Yazıcı K. 2006: Three new lichens from Turkey. Mycotaxon 97: 345–348.

Yazıcı K, Aslan A. 2007: Lichens and lichenicolous fungi from Bayburt province (Turkey). Acta Bot. Hun. 49: 199–213.

Yazıcı K, Aptroot A. 2007: Five lichen species new to Turkey. Mycotaxon 100: 21–26.

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Santa Catarina Island mangroves 1 – First report of *Myxomycetes* on *Avicennia schaueriana*

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Abstract — Mangroves are transitional coastal ecosystems linking marine and terrestrial environments, typically found in tropical areas. The total mangrove area in Brazil is one of the largest in the world, where austral limits/borders are in the State of Santa Catarina (Southern Brazil). During a survey about mangrove mycobiota on Santa Catarina Island, there were also collected and identified species of myxomycetes: *Stemonitis fusca*, *S. splendens* and *Physarum pezizoideum*. All specimens were gathered on *Avicennia schaueriana*. These species were collected for the first time in Brazilian mangroves and these are the first records of myxomycetes on *A. schaueriana*.

Key words — taxonomy, neotropical

Introduction

Mangroves are typically tropical vegetal formations located on the transition between terrestrial and aquatic environments, growing along low and protected shores in environments of sedimentation, like estuaries, salt lagoons and deltas (Ayala 2004). Along the American continent's Atlantic coast, the austral limit of mangroves occurrence is at the city of Laguna, located at latitude of 28° 55' S (Cintrón & Schaeffer-Novelli 1980). In Brazil, these ecosystems are well represented, corresponding to one of the six largest mangrove areas in the world (Lacerda 1984).

The occurrence of myxomycetes in mangroves appears to be rare (Nieves-Rivera & Stephenson 2004). Even though the mangrove ecosystems provide a range of potential habitats for myxomycetes, it is possible that regular inundation by the sea inhibit their regular development (Ing 1994).The first mangrove myxomycete species reported was *Arcyria cinerea* (Bull.) Pers., which was collected in 1968 (Oahu, Hawaii) on a branch of *Rhizophora mangle* L. (Kohlmeyer 1969). Afterward, Lee & Baker (1973) reported *Arcyria virescens* G. Lister, *Ceratiomyxa* sp. and *Physarum* sp. from living roots of *R. mangle* at the same locality. Ing & Hnatiuk (1981) gathered *Physarum globuliferum* (Bull.) Pers. on mangrove poles, in Aldabra Atoll, western Indian Ocean. In Puerto Rico, Nieves-Rivera & Stephenson (2004) reported the occurrence of *Stemonitis splendens* on *R. mangle* in Cabo Rojo.

In spite of myxomycetes' ecological significance for these ecosystems, as organic matter decomposers, only one study on Brazilian myxobiota in mangroves was carried out in northern and northeastern Brazil, in Pernambuco, Sergipe and Pará states (Cavalcanti et al. 2000). In this survey, thirteen taxa, gathered on *R. mangle* and *Laguncularia racemosa* (L.) C.F.Gaertn. mangrove trees were identified.

The myxomycete studies in Santa Catarina state had started by the end of the XIX century, with E. Ule's and A. Möller's collections. A total of 47 taxa of myxomycetes are recorded for Blumenau, Joinville, Itajaí, Tubarão and Florianópolis (Cavalcanti & Fortes 1994). So far, no myxomycete species have been gathered in mangrove areas in the State of Santa Catarina.

The main objective of the present work is to expand the myxobiota knowledge of Brazilian mangroves.

Materials and methods

Santa Catarina Island is located in the central-east of the State of Santa Catarina (27°35' S and 48°32' W) and belongs to Florianópolis municipality. Mangroves are set up only in the western shores of the island, where there are low-energy environments. The four largest mangroves on the island are located in the following river mouths: Ratones (29° 30' 00" S and 48° 27' 00" W), Saco Grande (28° 37' 30" S and 48° 27' 30" W), Itacorubi (27° 34' 14" S and 48° 30' 07" W) and Tavares (27° 38' 40" S and 48° 30' 17" W).

The typical mangrove trees from these areas are *Avicennia schaueriana* Stapf & Leechm. ex Moldenke, *L. racemosa* and *R. mangle*. The species *A. schaueriana* (also known as black-mangrove or "siriuba") forms phytophysiognomic dominance of these ecosystems (Bigarella 1946, Souza-Sobrinho et al. 1969).

During a survey of xylophilous fungi in Santa Catarina Island mangroves, from May/2005 to August/2006, myxomycete specimens were also collected, always being found on the typical mangrove trees. The specimens were analyzed macro- and micromorphologically, identified using specialized literature and compared with herbarium collections.

Colours are coded according to Munsell (1975). Herbarium names are abbreviated according to the Index Herbariorum (Holmgren et al. 1990). The examined materials are preserved in Herbarium FLOR.

Descriptions, comments, illustrations and a key of the species collected are given, as well as a key for the determination of myxomycete genera collected in mangroves around the world.

Results and discussion

A total of six myxomycete specimens were collected and identified as: *Stemonitis fusca, S. splendens* and *Physarum pezizoideum*. All the species had *A. schaueriana* bark as their substrate.

The three species were gathered from the Itacorubi mangrove and only one *S. splendens* specimen was gathered from the Saco Grande mangrove. There were no myxomycetes collected on the Ratones or the Tavares River mangroves.

Key for the determination of myxomycete species gathered on Santa Catarina Island mangroves, SC, Brazil

1 Discoid or saucer-shaped sporothecae, deposits of calcium carbonate present, spores 10-13 µm .... *Physarum pezizoideum*

1' Cylindrical sporothecae, deposits of calcium carbonate absent, spores 8-10 µm 2

2 Sporocarps 9-15 mm high, spore surface with warty-reticulate ornamentation .... *Stemonitis fusca*

2' Sporocarps 13-19 mm high, spores surface with warty ornamentation .... *S. splendens*

Descriptions

Physarum pezizoideum (Jungh.) Pavill. & Lagarde,
Bull. Soc. mycol. Fr. 19:87, 1903. FIGURES 1-2

Sporocarps single or caespitose, gregarious, stalked. Sporothecae flat discoid to saucer-shaped, 2.5-4.0 mm high. Peridium squamulose, calcium carbonate present, light grey (5YR 7/1) to reddish grey (10YR 6/1), dehiscence irregular. Capillitium threads hyaline in transmitted light, nodes covered with calcarium. Stalk slender, opaque, striate, 1.5-4.0 mm high, reddish brown (2.5 YR 4/4) to dark reddish brown (2.5YR 3/4). Spores globose, thin-walled, with warty ornamentation on the surface, 10-13 µm, pale violet in 1% KOH. Spore-mass dark reddish brown (5YR 3/2).

SUBSTRATE — *A. schaueriana* dead tree.

DISTRIBUTION — cosmopolitan.

SPECIMENS EXAMINED — BRAZIL. SANTA CATARINA: **Florianópolis**. Ilha de Santa Catarina. Manguezal do Itacorubi. col. Trierveiler-Pereira & Maccarini *161*, 29.I.2006 (*FLOR 31878*). BRAZIL. SANTA CATARINA: **Florianópolis**. Ilha de Santa Catarina. Manguezal do Itacorubi. col. Trierveiler-Pereira & Marcon-Baltazar *191*, 24.II.2006 (*FLOR 31879*).

OTHER SPECIMENS EXAMINED—***P. compressum***: BRAZIL. RIO GRANDE DO SUL: **Porto Alegre**. Morro Santana. col. Rodrigues *081*. 15.III.1984 (*ICN 56693*). BRAZIL. RIO GRANDE DO SUL: **Porto Alegre**. Morro Santana. col. Rodrigues *204*. 29.VI.1984 (*ICN 56816*). BRAZIL. RIO GRANDE DO SUL: **Porto Alegre**. Morro Santana. col. Rodrigues

272. 12.IX.1984 (*ICN 56884*). BRAZIL. **Rio Grande do Sul: Porto Alegre**. Morro Santana. col. Rodrigues *173*. 31.V.1984 (*ICN 56785*). ***P. pezizoideum***: ARGENTINA. col. Castro. 3/V/1974 (*BAFC 23293*).

Comments — The spores of the examined specimens were larger than those described by Farr (1964) and Ukkola & Härkönen (1996). *P. pezizoideum* resembles *Physarum polycephalum* Schwein., but the former has more pronounced spore ornamentation and different stalk morphology (Camino et al. 2005). In the field, this species also resembles *Badhamia gigantospora* Ukkola & Härk. (Ukkola & Härkönen 1996), but that species has larger spores (19-22 µm). Only one record of *P. pezizoideum* is known in the State of Santa Catarina, from the city of Blumenau (Jahn 1902).

Stemonitis fusca Roth, Bot. Mag. (Römer & Usteri) 1(2): 26, 1787. FIGURES 3-4

Sporocarps single, gregarious, stalked. Sporothecae cylindrical, 7-14 mm high, dark brown (7.5YR 3/2). Stalk black (7.5YR N 2/), translucent, hollow, 7-13.5 mm high. Columella central, running to the apex of the sporotheca, then subdividing into several branches. Capillitium dark reddish brown in transmitted light, without calcic deposits. Spores globose, thin-walled, with warty-reticulate ornamentation on the surface, 8-10 µm, purplish brown in 1% KOH. Spore-mass dusky red (2.5YR 3/2).

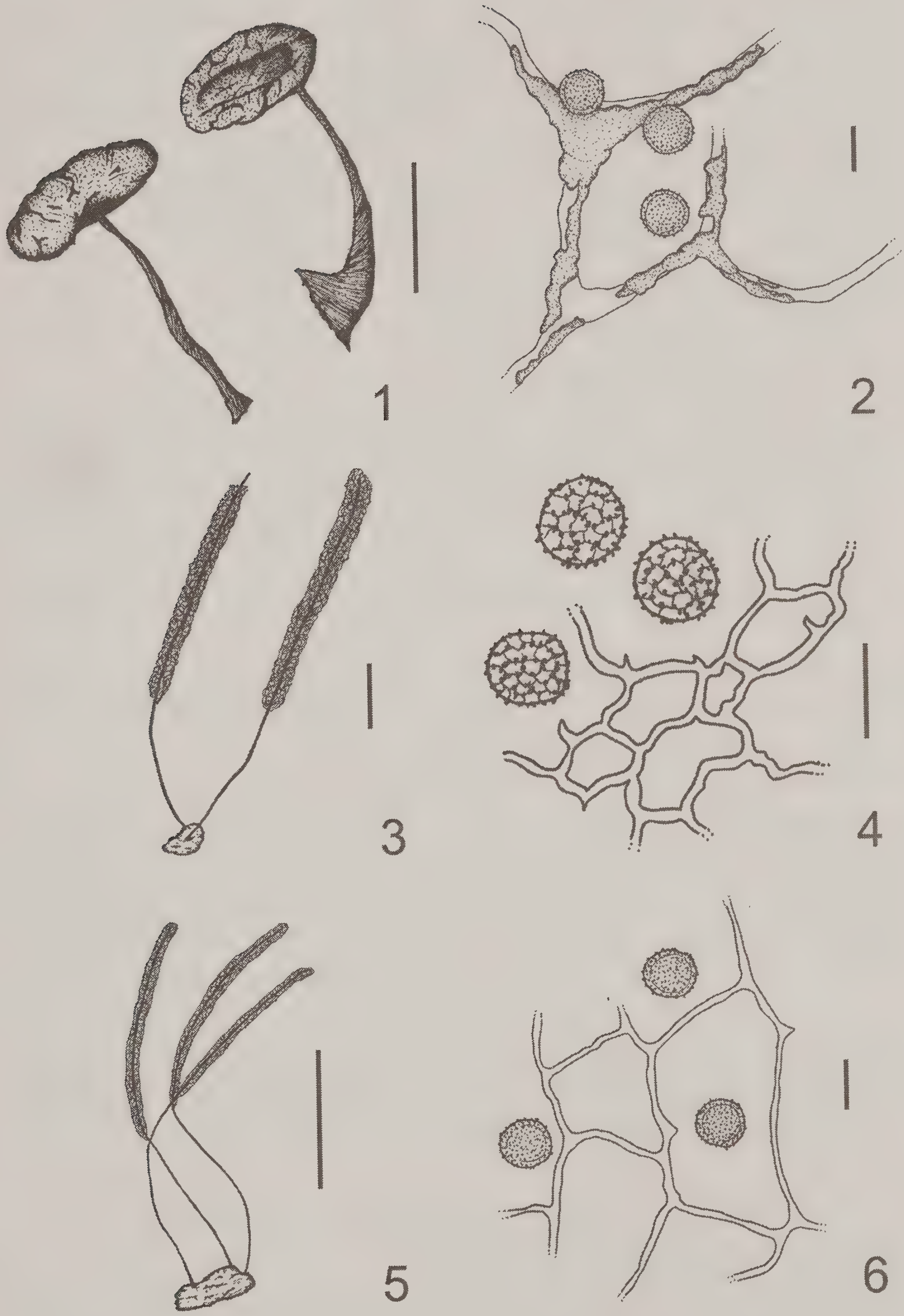
Substrate — *A. schaueriana* dead tree.

Distribution — cosmopolitan.

Specimens examined — BRAZIL. **Santa Catarina: Florianópolis**. *Ilha de Santa Catarina. Manguezal do Itacorubi. col. Trierveiler-Pereira & Name 010. 01.IV.2005 (FLOR 31878)*. BRAZIL. **Santa Catarina: Florianópolis**. *Ilha de Santa Catarina. Manguezal do Itacorubi. col. Trierveiler-Pereira & Marcon-Baltazar 192. 24.II.2006 (FLOR 31879).*

Other specimens examined — BRAZIL. **Rio Grande do Sul: Porto Alegre**. *Morro Santana. col. Rodrigues 081. 15.III.1984 (ICN 56693)*. BRAZIL. **Rio Grande do Sul: Porto Alegre**. *Morro Santana. col. Rodrigues 204. 29.VI.1984 (ICN 56816)*. BRAZIL. **Rio Grande do Sul: Porto Alegre**. *Morro Santana. col. Rodrigues 272. 12.IX.1984 (ICN 56884)*. BRAZIL. **Rio Grande do Sul: Porto Alegre**. *Morro Santana. col. Rodrigues 173. 31.V.1984 (ICN 56785).*

Comments — *S. fusca* is a very ordinary species with very variable morphology (Teixeira 1971). Castillo et al. (1997) concluded that this is a species variable in the size of sporocarp, stalk, capillitium and in colour. The material is similar to other specimens examined, being different only in the darker coloured sporocarps (ICN 56785) and with a slightly smaller spores (ICN 56884). Essentially, the spore ornamentation pattern (warty-reticulate) characterize the species. In the State of Santa Catarina, *S. fusca* has been previously reported from the cities of Blumenau (Jahn 1902), Itajaí (Hennings 1896) and Florianópolis (Cavalcanti & Fortes 1994).



Figures 1-6. 1-2. ***Physarum pezizoideum.*** 1: sporangia (scale bar = 1 mm), 2: capillitium detail and spores (scale bar = 10 µm). **3-4.** ***Stemonitis fusca.*** 3: sporangia (scale bar = 1 mm), 4: capillitium detail and spores (scale bar = 10 µm). **5-6.** ***Stemonitis splendens.*** 5: sporangia (scale bar = 5 mm), 6: capillitium detail and spores (scale bar = 10 µm).

Stemonitis splendens Rostaf.,
Śluzowce monogr. (Paryz): 195, 1874 ('1875') FIGURES 5-6

Sporocarps single, gregarious, stalked. Sporothecae cylindrical, 13-19 mm high, dark reddish brown (5YR 3/2) to dark brown (7.5YR 3/2). Stalk black (7.5YR N 2/), translucent, hollow, 13-18 mm high. Columella central, reaching nearly to the sporotheca apex. Capillitium dark reddish brown in transmitted light, without calcaric deposits. Spores globose, thin-walled, with warty ornamentation on the surface, 8-10 µm, purplish brown in 1% KOH. Spore-mass very dark greyish brown (10YR 3/2).

SUBSTRATE — *A. schaueriana* dead tree.

DISTRIBUTION — cosmopolitan.

SPECIMENS EXAMINED — **BRAZIL. SANTA CATARINA: Florianópolis**. Ilha de Santa Catarina. Manguezal do Itacorubi. col. Trierveiler-Pereira & Maccarini *145*. 29.I.2006 (*FLOR 31880*). **BRAZIL. SANTA CATARINA: Florianópolis**. Ilha de Santa Catarina. Manguezal do Saco Grande. Marcon-Baltazar & Regolin *200*. 27.IV.2006 (*FLOR 31881*).

OTHER SPECIMENS EXAMINED — **BRAZIL. RIO GRANDE DO SUL: Porto Alegre**. Morro Santana. col. Rodrigues *294*. 30.XI.1984 (*ICN 56908*). **BRAZIL. RIO GRANDE DO SUL: Porto Alegre**. col. Rodrigues *320*. 12.IV.1986 (*ICN 56934*).

COMMENTS — The spores of the compared material are slightly smaller (7-8 µm), however, Rodríguez-Palma & Estrada-Torres (1996) noticed that *S. splendens* is a highly variable species, showing differences in the size and colour of the sporocarps, mesh size, expansions in the capillitium and columella apex, and the colour, size and ornamentation of the spores. In the State of Santa Catarina, the species has been previously reported from Blumenau (Jahn 1902) and Florianópolis (Cavalcanti & Fortes 1994). In Puerto Rico, it was found growing on *Rhizophora mangle* decayed fallen trunks (Nieves-Rivera & Stephenson 2004).

To facilitate the identification of myxomycete genera gathered in mangrove areas, the following key was made, based on bibliographic references (Teixeira 1971, Rodrigues & Guerrero 1990, Moreno et al. 2001).

Key for the determination of myxomycete genera on mangrove trees

1. Pseudocapillitium present and columella absent .... *Licea*
1' Capillitium and columella present 2

2. Sporocarps stalked and tiny (up to 0.5 mm tall) .... *Echinostelium*
2' Sporocarps stalked or sessile, taller than 0.5 mm 3

3. Spores produced externally to sporangium. .... *Ceratiomyxa*
3' Spores produced internally to sporangium 4

4. Sporocarp with some calcarium material 5

4’ Sporocarp without calcarium material 7

5. Capillitium with calcium carbonate present .... *Physarum*

5’ Capillitium with calcium carbonate absent. 6

6. Peridium without calcium carbonate .... *Diachea*

6’ Peridium with calcium carbonate .... *Didymium*

7. Columella present and capillitium without ornamentations. 8

7’ Columella absent and capillitium ornamented 10

8. Sporotheca globose, peridium persistent and iridescent .... *Lamproderma*

8’ Sporotheca cylindrical, peridium evanescent, with or without a superficial net arising from the capillitium 9

9. Superficial net present, stalk base fibrous .... *Stemonitis*

9’ Superficial net absent, stalk base not fibrous .... *Comatricha*

10. Capillitial threads ornamented with well- defined spirals .... *Hemitrichia*

10’ Capillitial threads ornamented with spines, warts, rings or half-rings, reticulations or poorly-defined spirals. 11

11. Capillitial threads short, simple or slightly ramified, rarely forming a complete net. .... *Perichaena*

11’ Capillitial threads long, well-ramified and anastomosed, forming a complete isodiametric net .... *Arcyria*

Conclusions

Myxobiota in mangroves is still barely known throughout the world. The present work contributes to this knowledge. These are the first records of myxomycetes in Brazilian mangroves and represents the first occurrences of myxomycetes on *Avicennia schaueriana.*

At this time, sixteen myxomycete taxa are known for Brazilian mangroves, demonstrating an important research field for these organisms.

Inventorying the diversity of organisms, especially communities of lower organisms such as fungi and myxomycetes, supplies information that can be used as tools for conservation and management of mangrove forests.

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The authors are grateful to Laise de Holanda Cavalcanti (Brazil), Carlos Illana (Spain), Andrea Romero (Argentina) and David Minter (United Kingdom) for supplying literature. We are grateful to David W. Mitchell (United Kingdom) and Jouko Rikkinen (Finland) for critically reading the manuscript. We also acknowledge Fernando Name, Thiago Bernardes Maccarini and André Regolin for their help with the field work. This study was partly supported by PIBIC/CNPq/UFSC (Brazil).

Literature cited

Ayala L. 2004. A relação do espaço na evolução morfodinâmica do manguezal do Itacorubi, Florianópolis, SC (Tese de Doutorado em Geociências, Instituto de Geociências, Rio Grande do Sul, Brasil). 242p.

Bigarella JJ. 1946. Contribuição ao Estudo da Planície Litorânea do Estado do Paraná. Arquivos de Biologia e Tecnologia 1: 75-111.

Cavalcanti LH, Fortes ST. 1994. Myxomycetes de Florianópolis (Santa Catarina - Brasil). Acta bot. Bras. 8(1):65-75.

Cavalcanti LH, Bezerra ACC, Lopes EC. 2000. Diversidade da mixobiota de manguezais. Mangrove 2000. CD-ROM, Full papers. International Society for mangrove Ecosystems.

Cintrón G, Schaeffer-Novelli Y. 1980. Introducción a la ecologia del manglar. Departament of Natural Resources, San Juan; Instituto Oceanográfico USP, São Paulo. 146p.

Hennings P. 1896. Beitrage zur Pilzflora Sudamerikas. I. Myxomycetes, Phycomycetes, Ustilaginae und Uredinae. Hedwigia 35: 207-262.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I. The herbaria of the world, 8th ed. New York botanical Garden, Bronx.

Ing B, Hnatiuk R. 1981. Myxomycetes of Aldabra Atoll. Atoll Research Bulletin 249:1-10.

Ing B. Tansley review no. 62. The phytosociology of myxomycetes. New Phytol. 126:175–201. 1994.

Jahn E. 1902. Myxomycet estudien. 2. Arten aus Blumenau (Brasilien). Ber. Deutsch. Bot. Ges. 20: 268-280.

Kohlmeyer J. 1969. Ecological notes on fungi in mangrove forests. Trans. Br. Mycol. Soc. 53: 237–250.

Lacerda LD. 1984. Manguezais: florestas de beira-mar. Ciência Hoje 3(13):62-70.

Lee BKH, Baker GE. 1973. Fungi associated with the roots of red mangrove, *Rhizophora mangle*. Mycologia 65(4): 894-906.

Moreno G, Illana C, Castillo A, García JR. Myxomycetes de Extremadura Campiña Sur. 122p. 2001.

Munsell L. 1975. Munsell soil color charts. United Status Department Agricultura Hand. 18. Soil Survey Manual.

Nieves-Rivera AM, Stephenson SL. 2004. The occurrence of *Stemonitis splendens* (Myxomycota: Stemonitales) on *Rhizophora mangle*. Caribbean J. Sci. 40:273-276.

Rodrigues CLM, Guerrero RT. 1990. Myxomycetes do Morro Santana, Porto Alegre, Rio Grande do Sul. Boletim do Instituto de Biociências 46: 3-95.

Souza-Sobrinho RJ, Bresolin A, Klein RM. Os manguezais da Ilha de Santa Catarina. Insula 2:1-21. 1969.

Teixeira AR. 1971. Gêneros de Myxomycetes. Rickia supl. 4: 1-150.

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Myxomycetes of Sonora, Mexico. 4: Sierra de Alamos-Rio Cuchujaqui Biosphere Reserve

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Abstract – Thirty-one species of myxomycetes from the protected area Sierra de Alamos - Rio Cuchujaqui were studied. Fifteen taxa are new records for the Mexican state of Sonora: *Cribraria fragilis, Diachea bulbillosa, D. leucopodia, Diderma effusum, D. hemisphaericum, Fuligo megaspora, Licea castanea, Oligonema schweinitzii, Physarella oblonga, Physarum auriscalpium, P. bogoriense, P. cinereum, P. viride, Stemonaria longa* and *Stemonitis mussooriensis.* Including these new records, eighty-one taxa have now been described for the Sonoran myxobiota. The species studied are discussed and photomicrographs of their macro- and microscopic characters are provided for some of them.

Key words – myxomycota, chorology, taxonomy, SEM

Introduction

The Sierra de Alamos – Rio Cuchujaqui region was decreed as a wildlife protection area in 1996 and a Biosphere Reserve by UNESCO on September 18, 2007. This protected region, which is located at 27°12'–26°53' N and 109°03'–108°29' W, comprises an area of 92,889 ha in southeastern Sonora in the municipality of Alamos. The climate is subhumid, with rain in summer, and the vegetation is mainly microphyllous desert scrub, tropical deciduous forest, oak forest, and pine-oak forest. Tropical dry forest covers 64.5% of the total area of Alamos.

This forest is characterized by high-elevation vegetation with mostly mesophilic and hydromorphic species, along with some spinose shrubs and succulent plants. An outstanding adaptive characteristic of the plants that comprise this type of vegetation is the nutrient reservoir contained in their root system. This makes it possible for the plant to quickly respond to rainfall in summer and also allows plants to survive and grow during drought. The latter phenomenon is documented for trees such as *Bursera laxiflora* S. Watson, *B. stenophylla* Sprague & L. Riley, *Ceiba acuminata* (S. Watson) Rose, *Ficus trigonata* L., *Haematoxylum brasiletto* H. Karst., *Lysiloma watsonii* Rose and *Taxodium mucronatum* Ten., which are found along the Cuchujaqui River. Other plants that are representative of this tropical forest include *Acacia cochliacantha* Willd., *Ambrosia ambrosioides* (Cav.) W.W. Payne, *Croton flavescens* Greenm., *Ipomoea arborescens* (Willd.) G. Don, *Pachycereus pecten-aboriginum* (Engelm.) Britton & Rose, *Pithecellobium sonorae* S. Watson, *Prosopis glandulosa* Torr. and *Vitex mollis* Humb. et al. Some macromycetes have been reported in association with these tropical deciduous forest plants in the Alamos Mountains (Esqueda et al. 1999).

There are 81 taxa of myxomycetes known for Sonora, including the fifteen new records for the Sierra de Alamos – Rio Cuchujaqui region. The distribution of the taxa in Mexico follows Moreno et al. (2007).

Materials and methods

The collections studied were gathered mainly in the field, but some were cultivated in moist chambers. Samples for light microscopy were mounted in Hoyer's medium and PVA following Schnittler & Novozhilov (1996) and Koske & Tessier (1983). Spores were measured, to include surface structures such as spines or warts, with an oil immersion lens. For ultramicroscopic studies, the material to be examined was rehydrated in concentrated ammonium hydroxide (28–30%) for 30 minutes, dehydrated in aqueous ethanol (70%) for 30 minutes, fixed for 2 hours in pure ethylene glycol dimethyl ether (= 1,2–dimethoxymethane) and finally immersed in pure acetone for at least 2 hours. This was followed by critical point drying and sputtering with gold-palladium.

The micrographs were taken at the University of Alcalá using a Zeiss DSM–950. This technique uses very little material (one sporocarp, a part of it or only a small portion of spores). Terminology used to describe spore ornamentation follows that of Rammeloo (1975a,b). For each species, the locality is included (see details in Table 1); collectors are abbreviated as follows: S. Chacón (SC), J. Cifuentes (JC), M. Esqueda (ME), S. Gómez (SG), M. Lizárraga (ML), E. Pérez-Silva (EPS), M. Rivera (MR), A. Sánchez (AS) and R. Valenzuela (RV); date and herbarium are also given. First records for the Sonoran myxobiota are indicated by an asterisk.

Table 1. Sampling localities in the Sierra de Alamos - Rio Cuchujaqui protected area.

LOCALITIES	N	W	ELEVATION	VEGETATION
1. La Cañita	26° 59' 31"	108° 38' 59"	643 m	TDF, OF
2. El Aguaje	26° 56' 49"	108° 41' 41"	491 m	TDSF, GF
3. El Cuzalito	26° 58' 33"	108° 39' 33"	713 m	OF
4. El Platanar	26° 59' 27"	108° 40' 40"	635 m	TDSF
5. Huerta Vieja	27° 02' 05"	109° 02' 54"	563 m	TDF
6. Mesa del Trigo	26° 58' 13"	108° 41' 19"	583 m	TDSF/SVSH
7. Palo Injerto	27° 03' 04"	108° 43' 52"	399 m	TDF/SVS
8. Promontorios	27° 00' 53"	109° 02' 11"	536 m	TDF
9. San Pedro	27° 03' 53"	108° 43' 44"	444 m	TDF

TDF: Tropical deciduous forest; OF: Oak forest; TDSF: Tropical deciduous and subdeciduous forest; GF: Gallery forest; SVS: Secondary vegetation of shrubs; SVSH: Secondary vegetation of shrubs and herbs.

Species List

Arcyria denudata (L.) Wettst., Verh. Zool.-Bot. Ges. Wien 35: Abh. 535 (1886)

SPECIMENS STUDIED: LOCALITY 5, leg. EPS, ML, ME, AS & MR, 21.XI.2005, on the decayed wood of *Ipomoea arborescens*, *CESUES* 7263.

OBSERVATIONS: This species has been cited for the Mexican states of Chiapas, Chihuahua, Jalisco, Morelos, Nuevo Leon, Puebla, Quintana Roo, Sonora, Tabasco, Tamaulipas, Veracruz and Yucatan and is commonly distributed in the tropical and subtropical regions of Mexico.

Comatricha elegans (Racib.) G. Lister, Guide Brit. Mycetozoa, ed. 3: 31 (1909)

SPECIMENS STUDIED: LOCALITY 1, leg. ML, ME, AS & MR, 23.XI.2005, on *Pseudotsuga menziesii* wood, *CESUES* 7276. It was cultivated in a moist chamber (01.XII.2005), fruiting on 20.XII.2005. Ibidem, 10.I.2006, *CESUES* 7284, *CESUES* 7279. LOCALITY 9, on *Pseudotsuga menziesii* wood, leg. ML, ME, AS & MR, 23.XI.2005, *AH* 31917. It was cultivated in a moist chamber (01.XII.2005), fruiting on 15.XII.2005.

OBSERVATIONS: *Comatricha elegans* was recently described for Chihuahua by Lizárraga et al. (2005b). The authors published photomicrographs of sporocarps by transmitted light and spore ornamentation under SEM. In Mexico, its known distribution is Chihuahua, Jalisco, Sonora, Tabasco and Veracruz.

Comatricha tenerrima (M.A. Curtis) G. Lister, Guide Brit. Mycetozoa, ed. 4: 39 (1919)

SPECIMENS STUDIED: LOCALITY 5, leg. EPS, ML, ME, AS & MR, 21.XI.2005, on the decayed wood of *Quercus* sp., *CESUES* 7262.

Observations: *Comatricha tenerrima* is characterized by sporocarps attenuating at the apex and spores 7-8 μm diam., ornamented as baculate under SEM with a stelliform to coralloid apex (Lizárraga et al. 1999a, 2005b, 2007). This taxon has been reported for Baja California, Chihuahua, Guerrero, Jalisco, Quintana Roo, Sonora, Tlaxcala, Veracruz and Yucatan.

****Cribraria fragilis*** Lado & Estrada, in Estrada et al.,
Mycologia 93(4): 744 (2001) Figs. 1–5

Specimens studied: Locality 8, leg. ML, ME, SC, RV & JC, 12.IX.2006, on decayed cactus, *AH* 31918.

Observations: The characteristic features of this species are the small sporocarps with violet hues, ca. 0.2-0.3 mm in total height, conspicuous calyculus, absence of peridial net at maturity; spores 8-9 μm diam., subglobose, with conspicuous longitudinal bands which form depression-like valleys where prominent and scattered warts are located visible under SEM; and its succulenticolous habitat. It can be distinguished from *Cribraria violacea* Rex by the globose and warted spores of the latter species; and from *Cribraria zonatispora* Lado et al., by the ellipsoidal shape and inconspicuous verrucose spores of the latter species. *C. zonatispora* also has succulenticolous habitat. It was described as a new species for the Mexican state of Morelos by Estrada et al. (2001).

****Diachea bulbillosa*** (Berk. & Broome) Lister, in Penzig,
Myxomyc. Fl. Buitenzorg: 45 (1898) Figs. 6–7

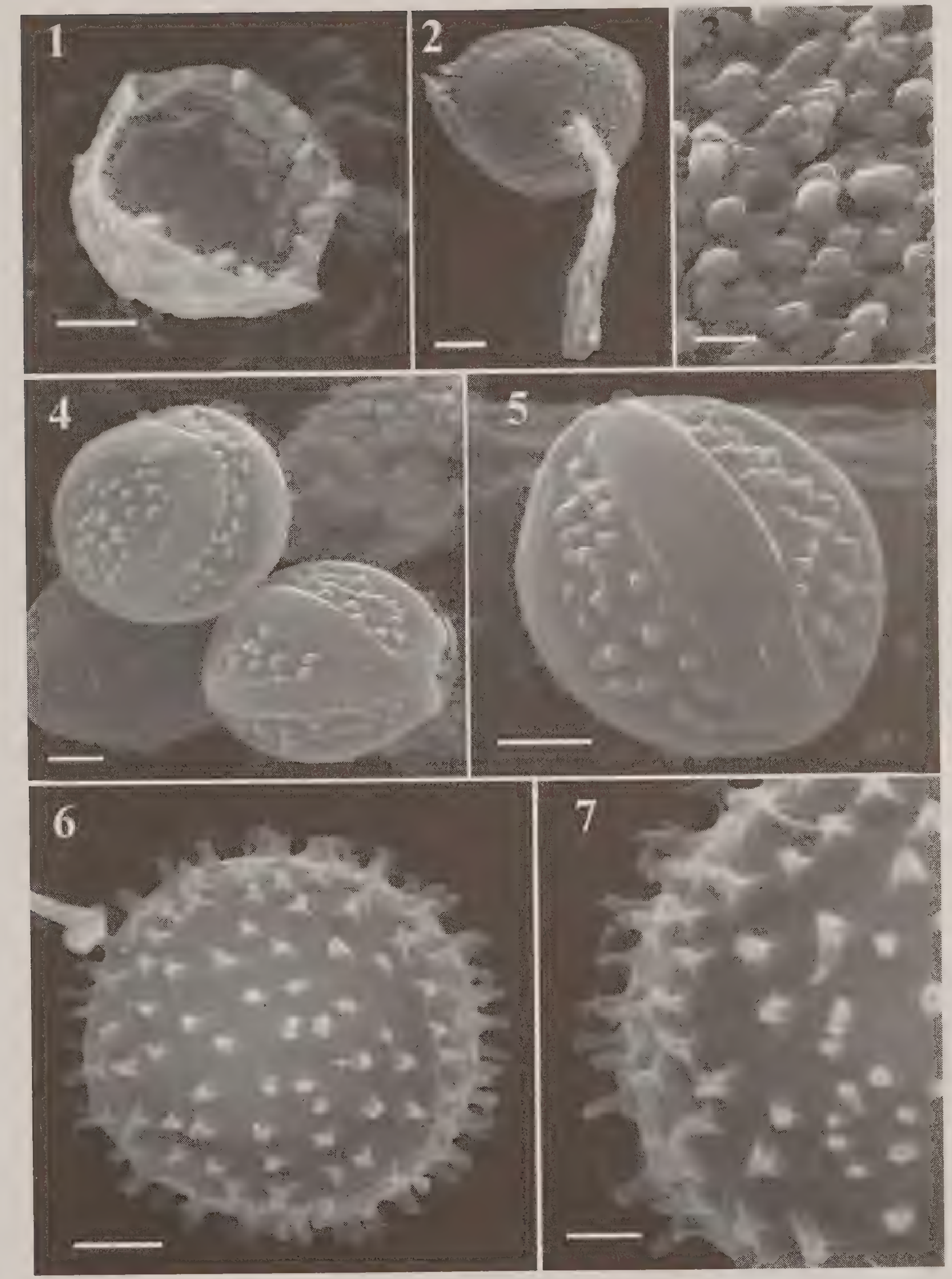
Specimens studied: Locality 4, leg. ML, ME, SC, RV & JC, 14.IX.2006, on dried *Quercus* sp. leaves, *AH* 31919. Ibidem, Locality 2, *CESUES* 7300.

Observations: The distinctive characters of this species are its stalked sporocarps; globose sporotheca; calcareous stalk, whitish to ochraceous-white, rigid and fragile; spores 9-11 μm diam., globose, conspicuously spinose; capillitium with dark purple filaments, (2-)3-4 μm diam., tapering with discoloration at the apex. Mexican collections showed spore ornamentation strongly spinose under SEM as was recently described for Cuban collections by Camino et al. (2005). It was previously recorded for the Mexican states of Jalisco, Quintana Roo and Veracruz.

****Diachea leucopodia*** (Bull.) Rostaf., Sluzowce Monogr.: 190 (1874)

Specimens studied: Locality 2, leg. ML, ME, SC, RV & JC, 14.IX.2006, on dried *Quercus* sp. leaves, *CESUES* 7299.

Observations: This cosmopolitan species was reported for Baja California, Chihuahua, Estado de Mexico, Jalisco, Morelos, Nuevo Leon, Sinaloa, Tlaxcala and Veracruz.



Figs. 1–5 *Cribraria fragilis* AH 31918: 1. Detail of inner side of calyculus. 2. Detail of outer side of calyculus and stalk. 3. Detail of outer side of calyculus ornamentation. 4. Spores. 5 Spore with longitudinal bands and scattered warts. Figs. 6–7 *Diachea bulbillosa* CESUES 7300: 6. Spore. 7. Detail of spore ornamentation. Scale bars. 1 = 500 μm. 2 = 20 μm. 3-6 = 2 μm. 7 = 1 μm.

Diderma effusum (Schwein.) Morgan, J. Cincinnati Soc. Nat.Hist. 16: 155 (1894)

> SPECIMENS STUDIED: LOCALITY 3, leg. ML, ME, SC, RV & JC, 15.IX.2006, on *Quercus* sp. leaves, *CESUES* 7307.

OBSERVATIONS: The distinctive characters of this taxon are the sessile and flattened sporocarps; globose to subglobose spores, 8–10 µm diam., verruculose with faint clusters of larger warts. *Diderma cubense* Berk. & M.A. Curtis is a synonym that was recently confirmed by Camino et al. (2005). These authors studied the type specimens. Although this is a cosmopolitan species (Martin & Alexopoulos 1969), there are few records for Mexico: Chiapas, Chihuahua, Jalisco, Quintana Roo, Veracruz and Yucatan.

Diderma hemisphaericum (Bull.) Hornem., Fl. Dan. 33: 13 (1829)

> SPECIMENS STUDIED: LOCALITY 8, leg. ML, ME, SC, RV & JC, 12.IX.2006, on *Quercus* sp. leaves, *CESUES* 7289.

OBSERVATIONS: This cosmopolitan species is commonly reported for Mexico: Baja California, Chiapas, Chihuahua, Nuevo Leon, Quintana Roo, Tabasco, Tlaxcala, Veracruz and Yucatan.

Diderma spumarioides (Fr.) Fr., Syst. Mycol. 3: 104 (1829)

> SPECIMENS STUDIED: LOCALITY 4, leg. ML, ME, SC, RV & JC, on dried *Quercus* sp. leaves, *AH* 31920.

Observations: The studied material is characterized by its densely clustered fructifications but with individual sporocarps amongst them, subglobose, whitish, embedded in a hypothallus; peridium thin, calcareous. Spore-mass black, globose, violet hues by transmitted light, 11–12 µm diam., ornamented with verrucae that are regularly distributed on the surface. The features observed in the collections agree with descriptions of Lizárraga et al. (2007). It has been cited for the Estado de Mexico, Jalisco, Quintana Roo, Sonora, and Yucatan.

Echinostelium apitectum K.D. Whitney, Mycologia 72(5): 954 (1980) **FIG. 8**

> SPECIMENS STUDIED: LOCALITY 1, leg. ML, ME, AS & MR, 23.XI.2005, on *Prosopis* sp. wood, *AH* 31916. It was cultivated in a moist chamber (01.XII.2005), fruiting on 15.XII.2005.

OBSERVATIONS: Previously reported in Mexico for Baja California Sur, Chihuahua, Sonora, and Tlaxcala.

****Fuligo megaspora*** Sturgis, Colorado Coll. Stud. Sci. Ser. 12: 443 (1913) **FIG. 9**

> SPECIMENS STUDIED: LOCALITY 4, leg. ML, ME, SC, RV & JC, 14.IX.2006, on dried *Quercus* sp. leaves, *AH* 31904, *CESUES* 7302.

OBSERVATIONS: This taxon is easily recognized by its whitish aethalia and typically large, dark spores, 15-20 µm diam., ornamented by strong crests, which are sometimes subreticulate. Under SEM, the spore ornamentation comprises irregular crests, which are occasionally anastomosed with the apex denticulate-verrucose. It has previously been recorded for some Mexican states: Colima, Jalisco, Nuevo Leon, Quintana Roo, Tlaxcala, and Yucatan.

Fuligo septica (L.) F.H. Wigg., Prim. Fl. Holsat.: 112 (1780)

SPECIMENS STUDIED: LOCALITY 1, leg. ML, AS, ME & MR, growing on *Pseudotsuga menziesi* wood at 1.2 m high, *CESUES* 7280.

OBSERVATIONS: A cosmopolitan taxon (Martin & Alexopoulos 1969) that has been widely cited for Mexico (Moreno et al. 2007).

Hemitrichia calyculata (Speg.) M.L. Farr, Mycologia 66(5): 887 (1974)

SPECIMENS STUDIED: LOCALITY 5, leg. EPS, ML, ME, AS & MR, 21.XI.2005, on the decayed wood of *Quercus* sp., *CESUES* 7265. LOCALITY 2, leg. ML, ME, AS & MR, 22.XI.2005, on the decayed wood of *Quercus* sp., *CESUES* 7273.

OBSERVATIONS: This species is regularly reported from Mexico: Baja California, Baja California Sur, Chiapas, Chihuahua, Guerrero, Hidalgo, Jalisco, Morelos, Nuevo Leon, Oaxaca, Quintana Roo, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, and Yucatan. This taxon is common in tropical zones.

Hemitrichia parviverrucospora (Lizárraga, G. Moreno & Illana) G. Moreno & Illana, in Pérez-Silva et al., Mycotaxon 77: 187 (2001)

SPECIMENS STUDIED: LOCALITY 5, leg. EPS, ML, ME, AS & MR, 21.XI.2005, on decayed *Quercus* sp. wood, *CESUES* 7264. LOCALITY 2, on the decayed wood of a palm tree, leg. ML, ME, AS & MR, 22.XI.2005, *CESUES* 7271. Ibidem, on *Quercus* sp. wood, *CESUES* 7272.

OBSERVATIONS: This species is recognized by its capillitium with very spiny ornamentation with spines frequently 4–7 µm long, spores reticulate with small warts within the meshes, visible only under SEM (Lizárraga et al. 1999b, Pérez-Silva et al. 2001). This species has been reported only for Central Africa and Mexico (Baja California Sur, Guerrero, Sinaloa and Sonora).

*****Licea castanea*** G. Lister, J. Bot. 49: 61 (1911)

SPECIMENS STUDIED: LOCALITY 9, leg. ML, ME, AS & MR, 24.XI.2005, on *Pseudotsuga menziesii* wood, *AH* 31915. It was cultivated in a moist chamber (24.II.2006), fruiting on 02.III.2006.

OBSERVATIONS: This species is characterized by its minute fructifications, ca. 0.1–0.3 mm in total height, yellowish brown to chestnut brown, dehiscence by polygonal plates; peridium overlaid with abundant granular material, inferior inner surface exhibiting numerous papillae. Spores globose, pale yellow in transmitted light, smooth, thick-walled, and with a conspicuous pale area. It is cited for Chihuahua, Tlaxcala, and Yucatan.

Lycogala flavofuscum (Ehrenb.) Rostaf., in Fuckel,
Jahrb. Nassauischen Vereins Naturk. 27–28: 68 (1873) **Figs. 10–12**

specimens studied: Locality 6, leg. ML, ME, SC, RV & JC, 14.IX.2006, on living *Quercus* sp. wood, *AH* 31910. Ibidem, Locality 4, on decayed wood, 21.XI.2005, *CESUES* 7270.

Observations: *Lycogala flavofuscum* is characterized by its pale to colourless pseudocapillitium comprising irregular tubes, 10–35 μm diam., ornamented by small warts or spines and its globose and transparent spores of 4–6 μm in diam, with an incomplete reticulum that is barely perceptible. With the SEM, one can observe that the reticulum is formed of several meshes of different widths, with a mesh-free zone and smooth reticulate walls. Reported for Baja California, Chiapas, Distrito Federal, Guanajuato, Jalisco, Michoacan, Sonora, Tamaulipas, and Tlaxcala.

Macbrideola decapillata H.C. Gilbert, Stud. Nat. Hist. Iowa Univ. 16: 158 (1934)

specimens studied: Locality 1, leg. ML, ME, AS & MR, 23.XI.2005, on *Quercus* sp. wood, *CESUES* 7277. It was cultivated in a moist chamber (01.XII.2005), fruiting on 9.XII.2005. Ibidem, 10.I.2006, *CESUES* 7283.

Observations: *Macbrideola decapillata* has been reported previously from the Mexican states of Chihuahua, Puebla, and Sonora. This rare species was described and photographed during recent research in Chihuahua (Lizárraga et al. 2003), Puebla (Keller & Braun 1977), and Sonora (Moreno et al. 2006).

Metatrichia horrida Ing, Trans. Brit. Mycol. Soc. 47(1): 51 (1964)

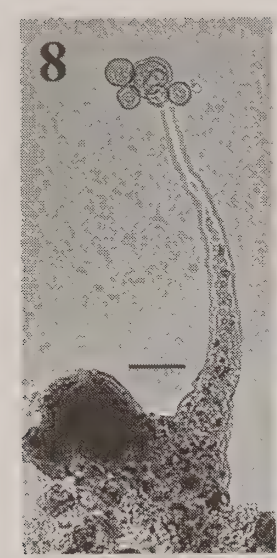
specimens studied: Locality 5, leg. EPS, ML, ME, AS & MR, 21.XI.2005, on the rotten wood of *Quercus* sp., *CESUES* 7261. Locality 6, on the decayed wood of *Acacia cochliacantha*, leg. ML, ME, AS & MR, 21.XI.2005, *CESUES* 7269.

Observations: A detailed description of this species and its comparison to *Metatrichia vesparium* (Batsch) Nann.-Bremek. ex G.W. Martin & Alexop., was given by Moreno et al. (1997), based on collections from Baja California Sur. Reported for Baja California Sur, Guerrero, Quintana Roo, Sinaloa, Sonora, Veracruz and Yucatan.

****Oligonema schweinitzii*** (Berk.) G.W. Martin, Mycologia 39(4): 460 (1947)
Figs. 13–20

specimens studied: Locality 2, leg. ML, ME. AS & MR, 23.XI.2005, on the decayed wood of *Quercus* sp, *CESUES* 7274. Locality 7, leg. ML, ME, SC, RV & JC, 13.IX.2006, on rotten wood of *Quercus* sp., *AH* 31908.

Fig. 8 *Echinostelium apitectum* AH 31916: Fructification and spores. Fig. 9 *Fuligo megaspora* AH 31904: Spore. Figs. 10–12 *Lycogala flavofuscum* AH 31910: 10. Detail of capillitium. 11. Spore. 12. Detail of spore ornamentation. Fig. 13 *Oligonema schweinitzii* AH 31908: Capillitium.
Scale bars. 8 = 10 μm. 9 and 13 = 2 μm. 10 = 5 μm. 11 = 1 μm. 12 = 0.5 μm.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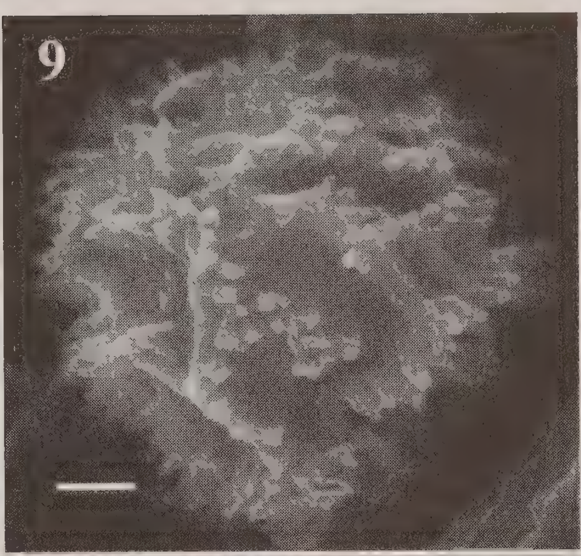
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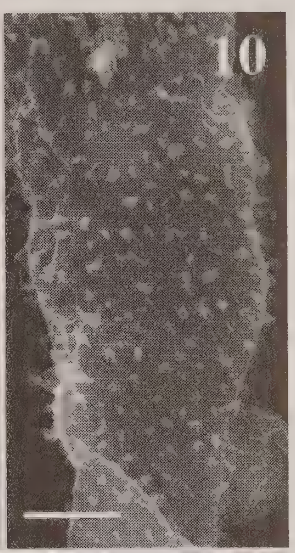
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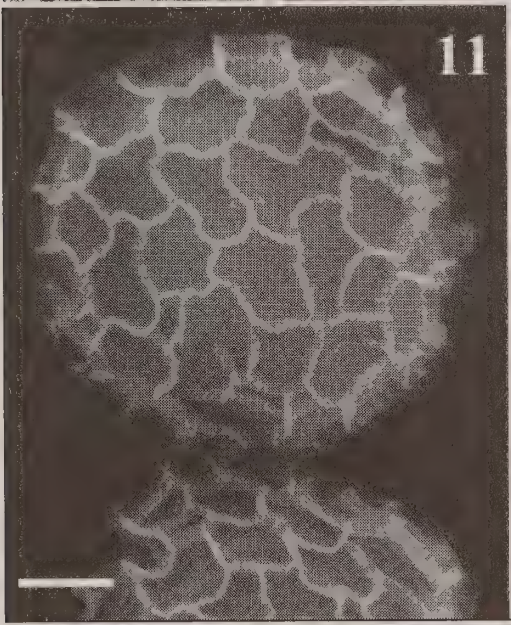
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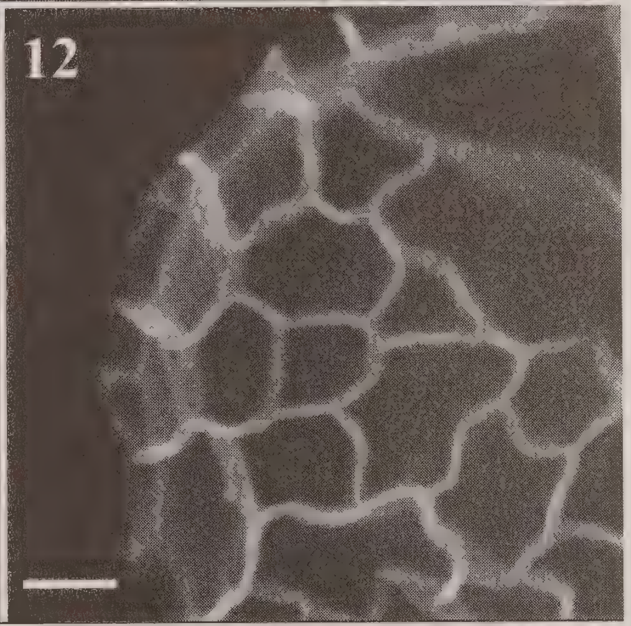
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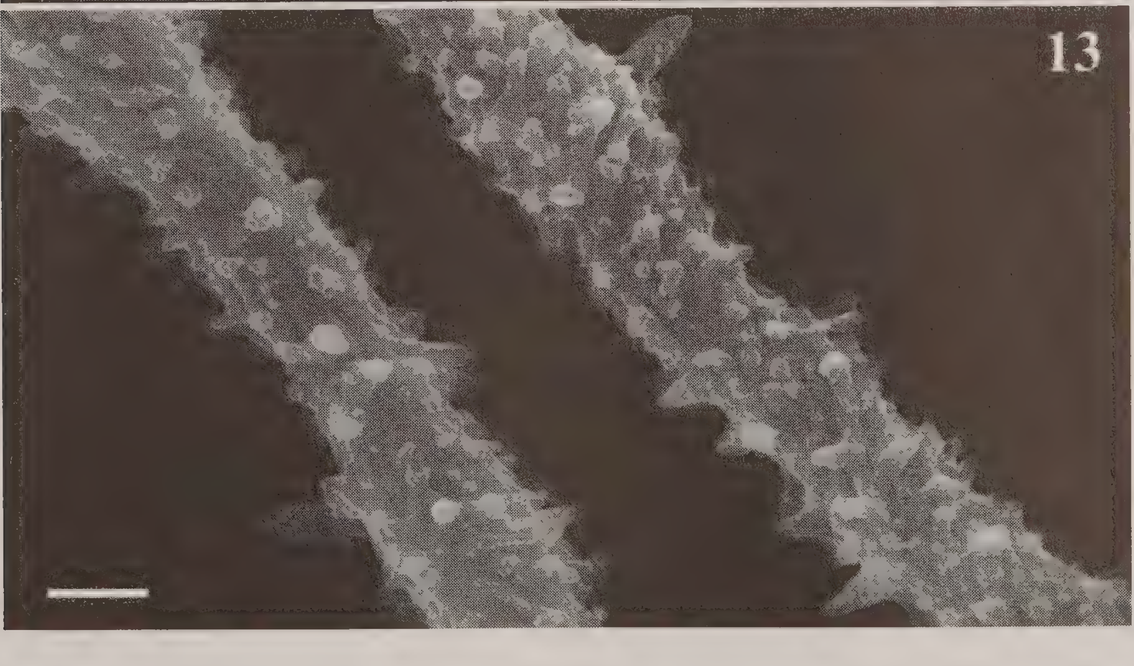
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Observations: *Oligonema schweinitzii* is characterized by its densely clustered, sessile, and subglobose sporocarps sometimes cylindrical to obconical in shape, over 1 mm in length and 0.5-0.9 mm in diam.; peridium is membranous, thin, and shiny, with the inner surface ornamented by dense warts visible with SEM but barely perceptible in transmitted light. Spore-mass yellow, light yellow by OM, globose to subglobose, 10-12 µm in diam, reticulate, with the reticule formed by several wide meshes somewhat irregular in shape. Under SEM, reticule formed of smooth walls, the upper portions of which are composed of smaller meshes of irregular widths. Capillitium is formed by yellow elaters, 3-4 µm in diam., and bearing warts that are conspicuous under the SEM.

The Mexican collection is characterized by its subglobose densely clustered sporocarps; verrucose inner peridium; narrow and wart-bearing capillitium and reticulate spores with meshes conspicuously wide and sometimes fragmented. It differs from the descriptions indicated for this species by authors such as Martin & Alexopoulos (1969), Rammeloo (1984), Neubert et al. (1993), and de Haan (2003) owing to the verrucose capillitium and the lack of smooth elaters that bear fine and smooth dextrose spirals.

A closely related species is *Oligonema flavidum* (Peck) Peck, which also has reticulated spores but with meshes that are closer; thus, the spore morphology is very different compared with Mexican collection, as we can see in the plates by Rammeloo (1984). For this reason we decided to identify it as *O. schweinitzii*. There was only one previous report of the genus *Oligonema* in Mexico: *O. schweinitzii,* which was reported by MacBride (1899) without specifying the locality. Thus, it has been considered as a dubious record in the catalogue of the myxomycetes of Mexico.

Perichaena depressa Lib., Pl. Crypt. Arduenna: 378 (1837)

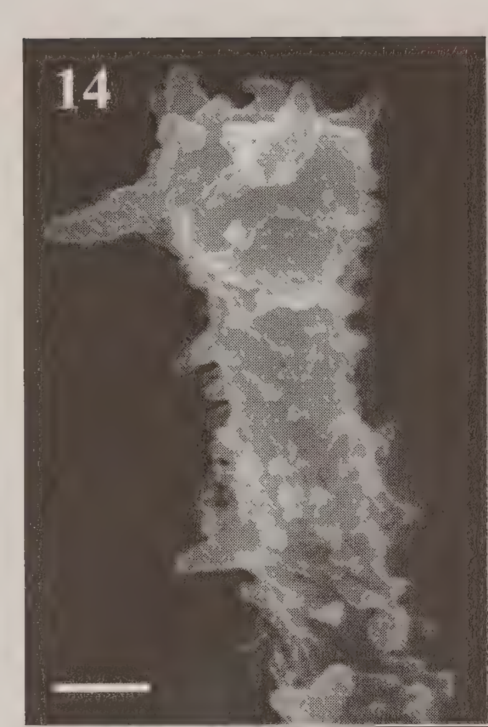
Specimens studied: Locality 2, leg. ML, ME, AS & MR, 22.XI.2005, on the decaying wood of *Quercus* sp., *CESUES* 7275.

Observations: Cited for Baja California, Baja California Sur, Chihuahua, Morelos, Puebla, Quintana Roo, Sinaloa, Sonora, Tlaxcala, Veracruz, and Yucatan. A cosmopolitan species that is easily recognized by its sporocarps, which are flat and bear a lateral dehiscence line that runs around them.

****Physarella oblonga*** (Berk. & M.A. Curtis) Morgan,
J. Cincinnati Soc. Nat. Hist. 19: 7 (1896)

Specimens studied: Locality 8, leg. ML, ME, SC, RV & JC, 12.IX.2006, on the decayed bark of *Quercus* sp., *CESUES* 7288, *CESUES* 7287.

Figs. 14–20 *Oligonema schweinitzii* AH 31908: 14–16. Detail of the thread ends of the capillitium. 17. Detail of inner side of peridium ornamentation. 18–20. Variation in spore ornamentation. Scale bars. 14, 16, 19-20 = 2 µm. 15, 17-18 = 5 µm.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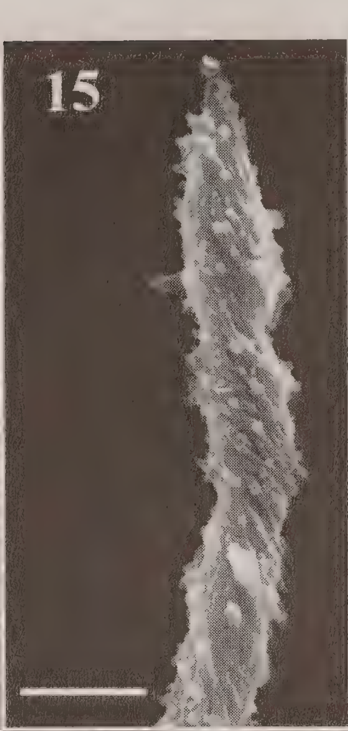
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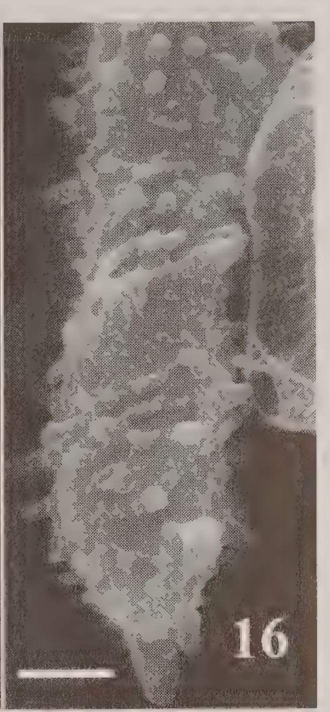
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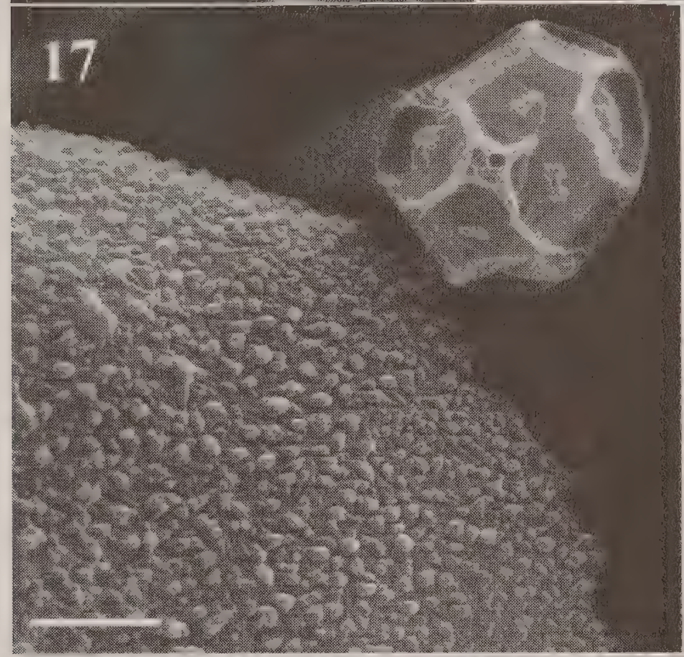
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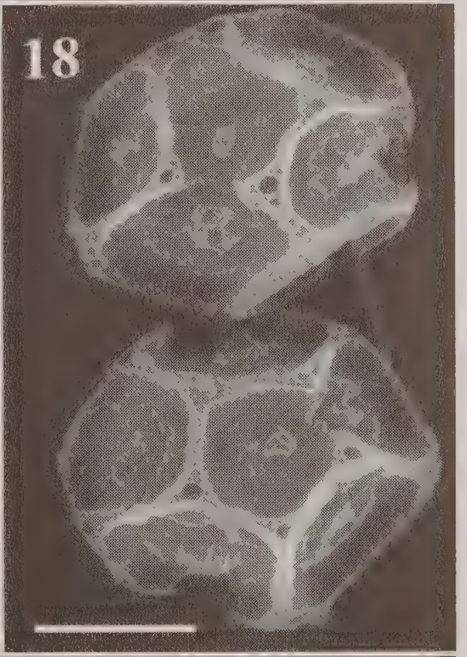
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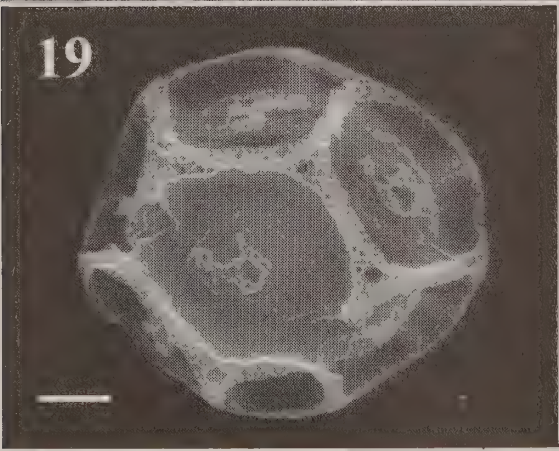
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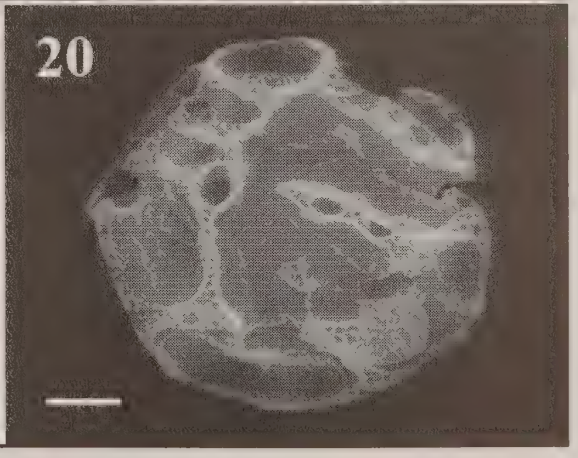
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Observation: *Physarella oblonga* was cited previously for Chiapas, Quintana Roo, Sinaloa, Veracruz, and Yucatan. This species has a rare tropical distribution in Europe.

*****Physarum auriscalpium*** Cooke, Ann. Lyceum Nat. Hist. New York 11: 384 (1877)

Specimens studied: Locality 2, leg. ML, ME, SC, RV & JC, 14.IX.2006, on the fallen leaves of *Quercus* sp., *AH* 31921.

Observations: This taxon is recognized by its sessile sporocarps, varying from subglobose to short plasmodiocarps; peridium orange; capillitium physaroid with whitish nodules. Spores 8-9 µm diam., globose, ornamented with spines and small groups of spines. Under SEM, spore ornamentation consists of tight rods in a semi-regular arrangement. It has been cited only for Baja California (Moreno et al. 2007).

*****Physarum bogoriense*** Racib., Hedwigia 37: 52 (1898) Figs. 21–22

Specimens studied: Locality 8, leg. ML, ME, SC, RV & JC, 12.IX.2006, on a fallen branch of *Quercus* sp., *AH* 31922.

Observations: *Physarum bogoriense* is characterized by its sporocarps with a double peridium: the external peridium is calcareous, yellow, and dehiscent by patches, while the internal peridium is membranous with an iridescent greyish colour. Spores 7-8 µm in diam., with conspicuous spiky ornamentation and compact groups of thicker spines. Under SEM, the ornamentation is shown as tightly packed rods. Cited from Guerrero, Nuevo Leon, Quintana Roo, Tlaxcala, Veracruz, and Yucatan.

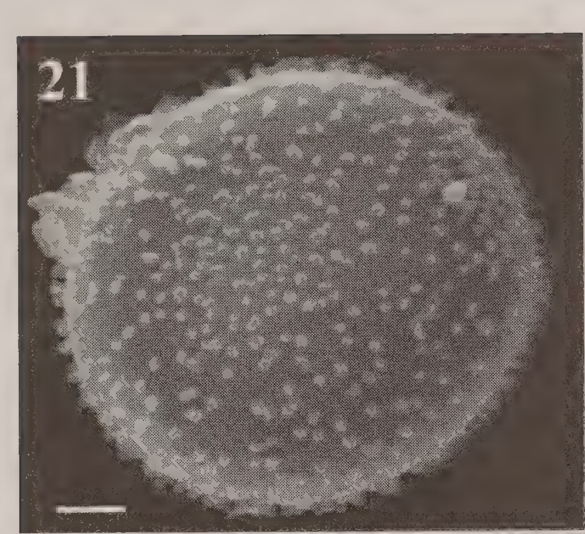
*****Physarum cinereum*** (Batsch) Pers., Neues Mag. Bot. 1: 89 (1794)

Specimens studied: Locality 7, leg. ML, ME, SC, RV & JC, 13.IX.2006, on bark of *Quercus* sp., *AH* 31914.

Observations: This species has fructifications that vary from globose sporocarps to short plasmodiocarps, whitish, with abundant pale nodules at the capillitium that are more or less subglobose in shape. Spores 9-10 µm in diam., violet in mass and light violet by transmitted light with groups of larger and darker warts. Cited from Baja California, Chihuahua, Guerrero, Jalisco, Nuevo Leon, Quintana Roo, Tlaxcala, Veracruz, and Yucatan. It is a cosmopolitan species (Martin & Alexopoulos 1969).

Figs. 21–22 *Physarum bogoriense* AH 31922: 21. Spore. 22. Detail of spore ornamentation. Figs. 23–26 *Stemonaria longa* AH 31905: 23. Detail of the thread ends of the capillitium. 24–25. Variation in spore morphology. 26. Detail of spore ornamentation.

Scale bars. 21 and 26 = 1 µm. 22 = 0.5 µm. 23 = 20 µm. 24-25 = 2 µm.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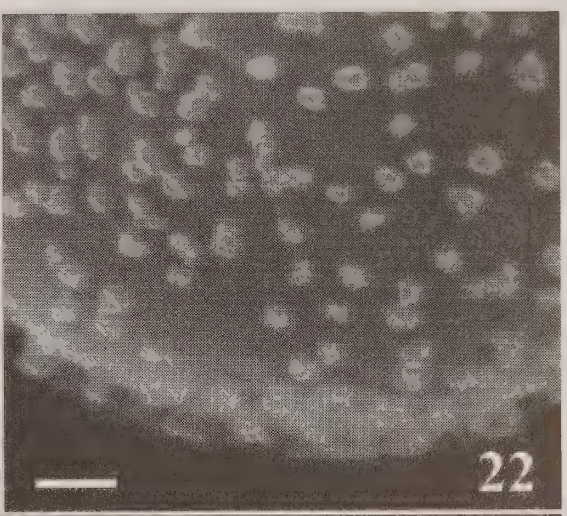
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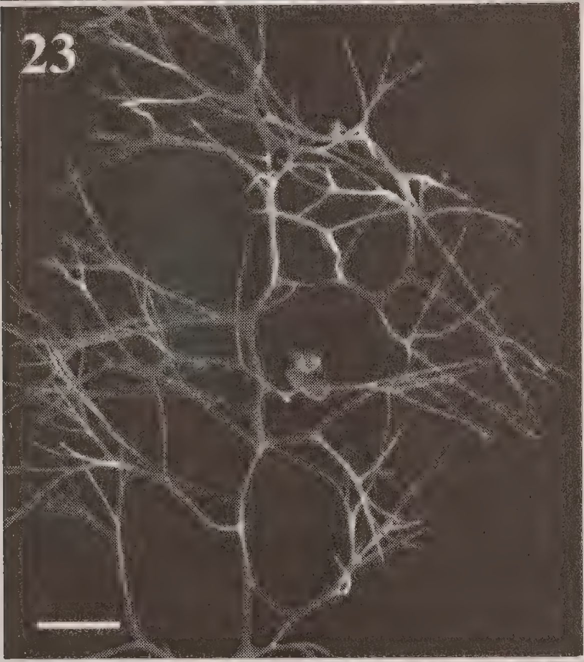
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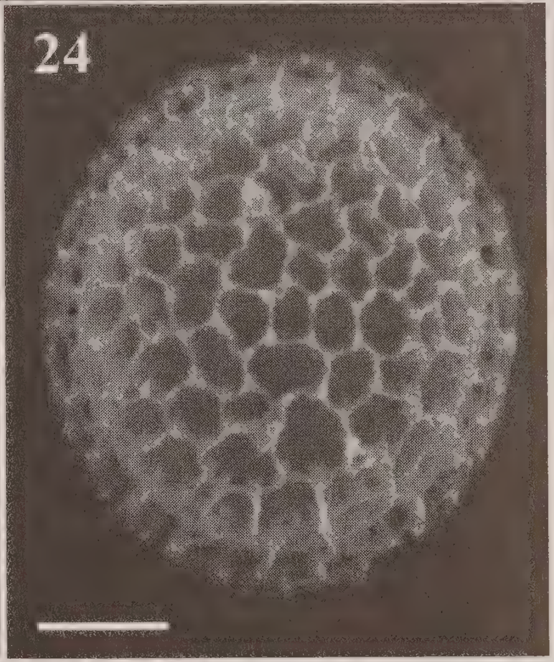
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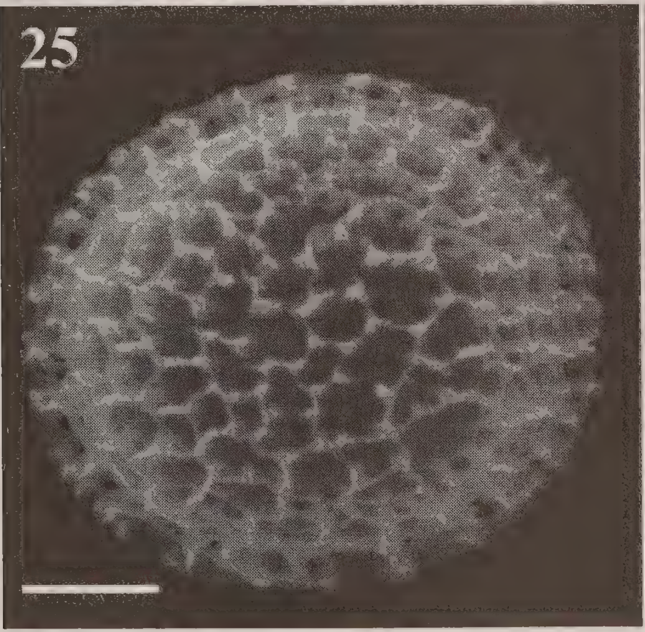
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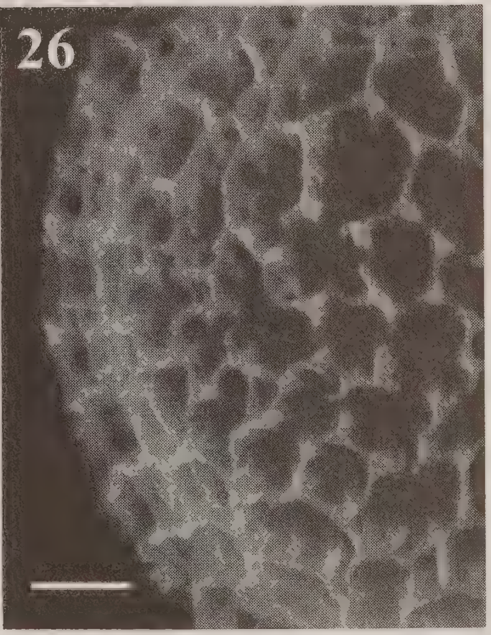
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Physarum compressum Alb. & Schwein., Consp. Fung. Lusat.: 97 (1805)

SPECIMENS STUDIED: LOCALITY 7, leg. ML, ME, SC, RV & JC, 13.IX.2006, on wood remains of *Quercus* sp., *CESUES* 7293.

OBSERVATIONS: This cosmopolitan species has been reported for Baja California Sur, Chiapas, Jalisco, Morelos, Nuevo Leon, Quintana Roo, Sinaloa, Sonora, and Veracruz.

Physarum globuliferum (Bull.) Pers., Syn. Meth. Fung.: 175 (1801)

SPECIMENS STUDIED: LOCALITY 6, leg. ML, ME, AS & MR, 21.XI.2005, on the decomposing wood of *Acacia cochliacantha*, *CESUES* 7268.

OBSERVATIONS: *Physarum globuliferum* is characterized by its stalked sporocarps; globose, whitish, sporotheca, with columella; calcareous whitish stalk; spores 7–8 µm diam., verrucose, with groups of more conspicuous and thicker warts on its surface. *P. tenerum* is a closely related species that differs from the former by its columella in a globose sporotheca, a calcareous stalk that is brownish-yellow and larger spores, which are 8–11 µm in diam. Previously reported from Chiapas, Quintana Roo, Sonora, Veracruz, and Yucatan.

*****Physarum viride*** (Bull.) Pers., Ann. Bot. (Usteri) 15: 6 (1795)

SPECIMENS STUDIED: LOCALITY 6, leg. ML, ME, SC, RV & JC, 14.IX.2006, on the rotten wood of *Quercus* sp., *CESUES* 7306.

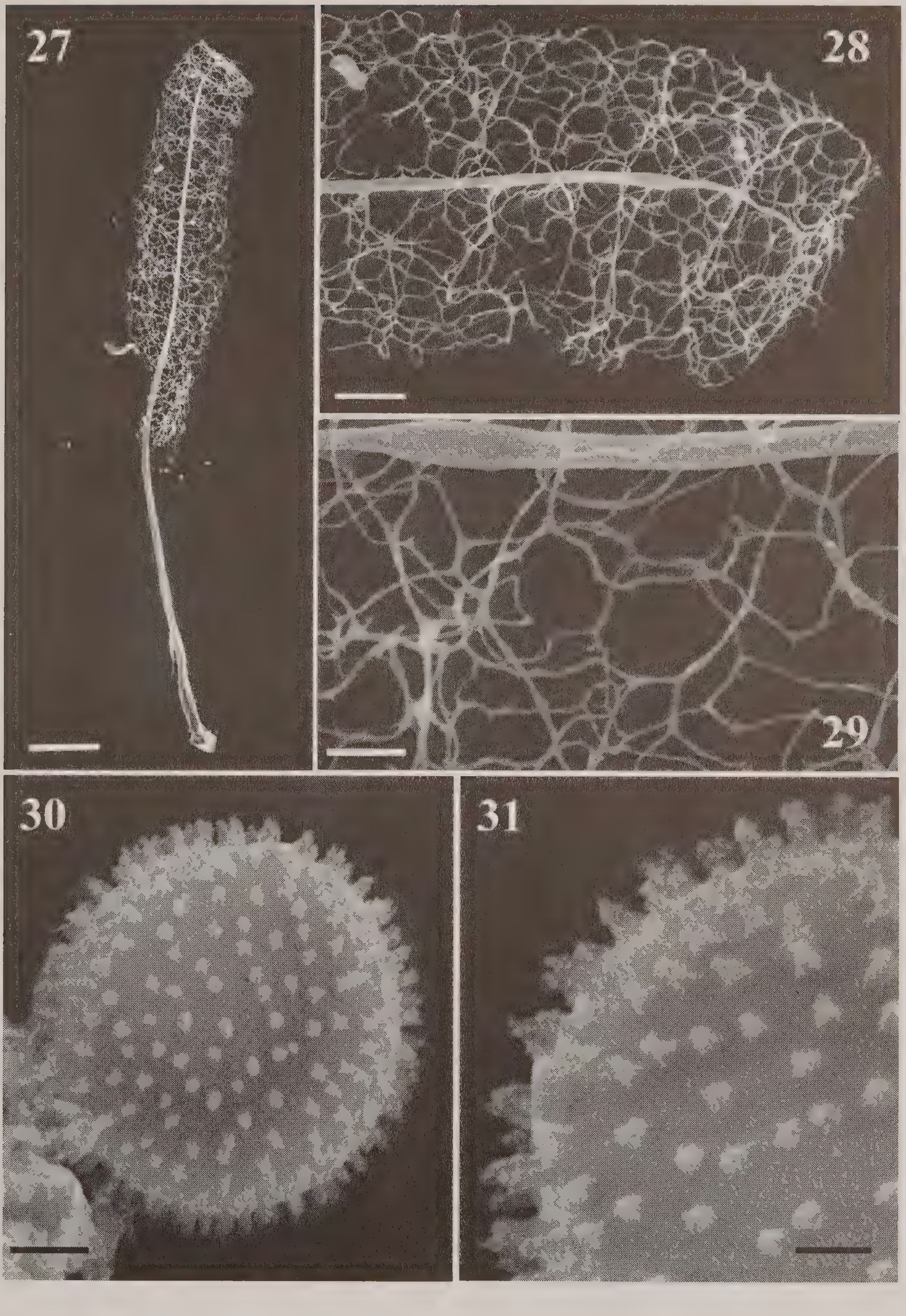
OBSERVATIONS: This cosmopolitan species is cited for Chihuahua, Estado de Mexico, Guerrero, Nuevo Leon, Quintana Roo, Tlaxcala, Veracruz, and Yucatan.

*****Stemonaria longa*** (Peck) Nann.-Bremek., R. Sharma & Y. Yamam.,
in Nannenga-Bremekamp et al., Proc. Kon. Ned. Akad. Wetensch.,
C. 87(4): 453 (1984) **FIGS. 23–26**

≡ *Comatricha longa* Peck, Annual Rep. New York State Mus. 43:70 (1890)

SPECIMENS STUDIED: LOCALITY 9, leg. ML, ME, SC, RV & JC, 13.IX.2006, on the decomposing remains of *Polyporaceae*, *CESUES* 7291. Ibidem, LOCALITY 2, 14–IX–2006, on the decomposing wood of *Quercus* sp., *AH* 31905, *CESUES* 7298.

OBSERVATIONS: This species is characterized by its quite long, pendulous sporocarps (more than 10 mm long), and by its open capillitium, with free branches and dichotomous terminations; spores 8-10 µm in diam., globose, which appear verrucose and reticulated by transmitted light. Under SEM, the reticulum is clearly observed, plus abundant meshes and pierced walls. This species has been cited for Chiapas, Jalisco, Quintana Roo, Veracruz, and Yucatan.



Figs. 27–31 *Stemonitis mussooriensis* AH 31923: 27. Sporotheca. 28. Detail of sporocarp apex. 29. Detail of capillitium. 30. Spore. 31. Detail of spore ornamentation.

Scale bars. 27 = 200 µm. 28 = 50 µm. 29 = 20 µm. 30 = 2 µm. 31 = 1 µm.

Stemonitis fusca Roth, Bot. Mag. (Römer & Usteri) 1(2): 26 (1787)

SPECIMENS STUDIED: LOCALITY 5, on wood remains of *Quercus* sp., leg. ML, ME, EPS, AS & MR, 21.XI.2005, *CESUES* 7260.

OBSERVATIONS: Previously reported for Baja California, Baja California Sur, Chiapas, Chihuahua, Jalisco, Nuevo Leon, Puebla, Quintana Roo, Sonora, Tabasco, Tamaulipas, Tlaxcala, Veracruz, and Yucatan. This cosmopolitan species is frequently found in Mexico.

Stemonitis mussooriensis G.W. Martin, K.S. Thind & Sohi,
Mycologia 49(1): 128 (1957) FIGS. 27–31

SPECIMENS STUDIED: LOCALITY 5, leg. ML, ME, SC, RV & JC, 12.IX.2006, on cortex of a liana, *AH* 31923.

OBSERVATIONS: This apparently rather rare species is characterized by its stalked fructifications 1.5–2.2 mm in total height, fruiting in small groups. Sporotheca 1.1–1.6 x 0.3–0.4 mm, cylindrical, dark brown. Peridium evanescent. Stalk short, about one third the total height of the sporocarp. Membranous hypothallus. Capillitium violet-brown which forms an inner and loose net with few free terminations; it may break towards the apex, and bears a more or less abundant number of spines. Central columella tapering towards the apex. Spore mass brownish-black, dark violet by transmitted light, 10–12 μm in diam., globose, conspicuously spiny ornamented, occasionally bearing a pale coloured area. Under SEM, spore ornamentation appears to be composed of long rods with irregular apexes and slightly denticulate.

This collection has been compared to the type material of *S. mussooriensis*, with which it coincides in all characters. There is only one report of *S. mussooriensis* cf., belonging to Veracruz (Lado et al. 2003), which reported smaller spores that did not exceed 10 μm in diam., with spines about 0.5 μm long.

Trichia affinis de Bary, in Fuckel,
Jahrb. Nassauischen Vereins Naturk. 23–24: 336 (1870)

SPECIMENS STUDIED: LOCALITY 2, leg. ML, ME, SC, RV & JC, 14.IX.2006, on the woody remains of *Quercus* sp., *CESUES* 7301.

OBSERVATIONS: A SEM study in which the elaters and spore ornamentation can be appreciated for the Sonoran collections was done by Pérez-Silva et al. (2001). This species has been cited for Quintana Roo, Sonora, and Yucatan.

Acknowledgments

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Literature cited

Camino M, Moreno G, Castillo A. 2005. Taxonomic revision of the *Myxomycetes* from Cuba deposited in the Farlow Herbarium (USA). Mycotaxon 93: 379–400.

de Haan M. 2003. *Oligonema intermedium* sp. nov., een nieuwe myxomyceet (*Myxomycota*) uit België. Sterbeeckia 23: 3–8.

Esqueda M, Pérez-Silva E, Herrera T, San Martín F, Santos-Guzmán R. 1999. Macromicetos de selva baja caducifolia. I: Álamos, Sonora, México. Revista Mexicana de Micología 15: 73–78.

Estrada-Torres A, Lado C, Rodríguez-Palma M. 2001. Two new species of *Myxomycetes* from a tropical deciduous forest of Mexico. Mycologia 93: 744–750.

Keller HW, Braun KL. 1977. *Myxomycetes* of Mexico. II. Boletín de la Sociedad Mexicana de Micología 11: 167–180.

Koske RE, Tessier B. 1983. A convenient permanent slide mounting medium. Mycological Society of America Newsletter 34: 59.

Lado C, Estrada-Torres A, Stephenson SL, Wrigley de Lasanta D, Schnittler M. 2003. Biodiversity assessment of *Myxomycetes* from two tropical forest reserves in Mexico. Fungal Diversity 12: 67–110.

Lizárraga M, Illana C, Moreno G. 1999a. SEM studies of the *Myxomycetes* from the Peninsula of Baja California (Mexico), I. *Arcyria* to *Fuligo*. Annales Botanici Fennici 35: 287–306.

Lizárraga M, Illana C, Moreno G. 1999b. SEM studies of the *Myxomycetes* from the Peninsula of Baja California (Mexico), II. *Hemitrichia* to *Trichia*. Annales Botanici Fennici 36: 187–210.

Lizárraga M, Moreno G, Singer H, Illana C. 2003. *Myxomycetes* from Chihuahua, Mexico. Mycotaxon 88: 409–424.

Lizárraga M, Moreno G, Illana C, Singer H. 2005. *Myxomycetes* from Chihuahua, Mexico III. Mycotaxon 93: 75–88.

Lizárraga M, Moreno G, Esqueda M, Sánchez A, Coronado M. 2007. *Myxomycetes* from Sonora, 3: National forest reserve and wildlife refuge, Ajos-Bavispe. Mycotaxon 99: 291–301.

MacBride, TH. 1899. The North American Slime-Moulds, being a list of all species of *Myxomycetes* hitherto described from North America, including central America. The MacMillan Company, London.

Martin GW, Alexopoulous CJ. 1969. The *Myxomycetes*. University of Iowa Press, Iowa.

Moreno G, Lizárraga M, Illana C. 1997. *Metatrichia horrida* (*Myxomycetes*), an African species in the Baja California Peninsula (Mexico). Mycotaxon 64: 385–392.

Moreno G, Lizárraga M, Esqueda M, Pérez-Silva E, Herrera T. 2006. *Myxomycetes* de Sonora, Mexico. II: Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe. Revista Mexicana de Micología 22: 13–23.

Moreno G, Lizárraga M, Illana C. 2007. Catálogo de los *Myxomycetes* de México. Boletín de la Sociedad Micológica de Madrid 31: 187-229.

Neubert H, Nowotny W, Baumann K. 1993. Die Myxomyceten. Band 1 Ceratiomyxales, Echinosteliales, Liceales, Trichiales. Karlheinz Baumann Verlag, Gomeringen.

Pérez-Silva E, Herrera T, Esqueda M, Illana C, Moreno G. 2001. *Myxomycetes* of Sonora, Mexico. I. Mycotaxon 77: 181–192.

Rammeloo J. 1975a. Structure of the epispore in the *Stemonitales* (*Myxomycetes*) as seen with the scanning electron microscope. Bulletin de la Société Royale de Botanique de Belgique 45: 301–306.

Rammeloo J. 1975b. Structure of the epispore in the *Trichiaceae* (*Myxomycetes*) as seen with the scanning electron microscope. Bulletin de la Société Royale de Botanique de Belgique 107: 353–359.

Rammeloo J. 1984. Icones Mycologicae 35–54. Nationale Plantentium van België.

Schnittler M, Novozhilov Y. 1996. The *Myxomycetes* of boreal woodlands in Russian northern Karelia: a preliminary report. Karstenia 36: 19–40.

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Acaulosporaceae from El Palmar National Park, Entre Ríos, Argentina

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Abstract — The occurrence of arbuscular mycorrhizal fungi belonging to the genus *Acaulospora* in El Palmar National Park (Entre Ríos Province, Argentina) is reported. In this work *A. entreriana* sp. nov. is described and *A. denticulata, A. dilatata, A. elegans, A. foveata* and *A. rehmii* are reported and illustrated for the first time in Argentina. The distribution area of *A. bireticulata, A. delicata, A. excavata, A. laevis, A. mellea, A. scrobiculata* and *A. spinosa* was enlarged.

Key words — *Glomeromycota*, taxonomy, palm forest

Introduction

El Palmar National Park is one of the most floristically diverse national parks in Argentina. With over 700 vascular plant species (Biganzoli et al. 2001), the park shelters an important concentration of palm trees, *Butia yatay* (Mart.) Becc., that represents a characteristic edaphic community and one of the last *B. yatay* remnants in the region. Such protected areas have proved to serve as propitious places to conserve floristic biodiversity and associated microorganisms (Hawksworth 1991).

Amongst those symbiotic with land flora, arbuscular mycorrhizal fungi (AMF), which associate with 82% of plant species, are the most common soil fungi (Wang & Qiu 2006). Their ubiquity alone makes them an important component in the soil microbial biomass, and they are directly involved in crucial processes at the plant-soil interface (Harley & Smith 1983, McGee et al. 1989).

The abundance and diversity of AMF in El Palmar National Park is still unknown, although the park's protected environment makes it ideal for studying these microorganisms. Also, the park offers a wide range of vegetation including scrubland, marsh, palm forest, grassland and gallery forest. In brief, it is clear that vegetation and associated microorganisms within such areas should be protected (APN 1994).

Arbuscular mycorrhizal fungi represent four orders (Schüssler 2007) within the class *Glomeromycetes* (Cavalier-Smith 1988) and phylum *Glomeromycota* (Schüssler et al. 2001). Currently the *Glomeromycota* comprises 10 families and 13 genera (http://AMF-phylogeny.com 2007).

Of the arbuscular mycorrhizal genera in El Palmar National Park, *Acaulospora* species are the most dominant. Gerdemann & Trappe (1974) segregated the genus *Acaulospora* from *Endogone* to accommodate the type species, *Acaulospora laevis*, and another species included in their first key. Berch (1985) later added a third species and emended the generic description.

Acaulospora species possess a sporiferous saccule that is developmentally and structurally indistinguishable from the saccule produced by *Archaeospora* species (Morton & Redecker 2001). However, phylogenetic analyses suggest that this structure, which first appeared in *Archaeosporaceae*, was conserved within the *Acaulosporaceae* clade but lost during evolution of *Glomeraceae* (Redecker et al. 2000). Currently accepted *Acaulospora* species include 18 with smooth spore surfaces and 15 with ornamented outer spore walls. Oehl et al. (2006) provide the most recent key to the ornamented *Acaulospora* species.

The aim of this work is to describe and illustrate *Acaulospora* species recorded for the first time for Argentina and expand the known distribution for species previously cited for the country.

Materials and methods

Study area

Soil samples were taken from El Palmar National Park (58° 17' W, 31° 50' S), Entre Ríos Province, Argentina.

We selected 5 sites with different characteristics: 1-SCRUBLAND, dominated by *Baccharis dracunculifolia* and *Eupatorium buniifolium*; 2-MARSH displayed a different proportion of *Cyperaceae* and *Gramineae* were the following genera *Scirpus*, *Andropogon*, *Bromus* predominate; 3-PALM FOREST *Butia yatay* palm savannah; 4-GRASSLAND principal type physiognomical with grass and herbs of variable height and density; 5-GALLERY FOREST with exotic species as *Melia*, *Ligustrum*. Rhizospheric soil samples were collected using a composite random sampling method. Each sample contained three replicates.

Trap culture

In each of the 5 sites, three trap cultures were set up following Oehl et al. (2003). An autoclaved substrate consisting of a mixture of soil:perlite:vermiculite (3:1:1, w/w/w) was used. The AMF inocula containing 20 g per trap plant of unsterilized soil from field samples were placed in 27x17x20 cm pots.

Lolium perenne, Medicago sativa and *Plantago lanceolata* seeds were surface-sterilized with sodium hypochlorite (10% v/v) for 10 min and thoroughly rinsed with sterilized water. After germination, seedlings were selected for uniform size and then transplanted into pots, three of each species per trap culture. These pots were placed in a greenhouse at 24 ± 1°C day/ 20 ± 1°C night, and a 16-h photoperiod was provided by incandescent and cool-white lamps; the plants were fertilized with a nutritive solution (Cabello 1997).

Sampling of trap cultures

Trap cultures were grown for 90 days, then 2 soil core samples (15 cm^3; sampling depth, 10 cm) were taken from each pot for the extraction of AMF spores.

AMF spore isolation and identification

AMF were studied by spore extraction from soil samples or trap culture. Spores were extracted by wet-sieving and decanting (Gerdemann & Nicolson 1963) and the modified sucrose density gradient centrifugation method of Walker et al. (1982).

Fungal spores were examined using an optic microscope and mounted on polyvinyl-lactic acid-glycerine (PVLG) (Koske & Tessier 1983) or PVLG mixed 1:1 (v/v) using Melzer's reagent (Brundrett et al. 1994). Scanning electron microscope (SEM) was used to observe the different ornamentation in spore walls. Specimens were compared with original species described at the Germoplam Bank Institute Spegazzini, La Plata, Argentina; reference isolates described by the Internacional Culture Collection of Arbuscular and Vesicular-Arbuscular Micorrhizal Fungi (INVAM, USA, http://invam.cafwvu.edu), and Błaszkowski, http://www.agro.ar.szczecin.pl/~jbłaszkowski/. Terminology of the spore structure follows Stürmer & Morton (1999), as adapted by INVAM and modified by Oehl et al. (2006).

Figures 9–10 were photographed using a digital Olympus camera (model SP-350) on a stereoscopic microscope (Olympus SZ61); Figures 3–5, 7–8, and 11–14 were photographed on a Leitz Dialux 20EB compound microscope. Photographs (fig. 1, 2 and 6) were taken on a scanning microscope. Spores were prepared for scanning electron microscopy by rinsing them in distilled water, piercing them with a fine needle, and allowing them to air-dry on a metal stub. Dried spores were sputter-coated with gold/palladium and observed with a Jeol JSM-6360 LV microscope. Specimens mounted in PVLG and a mixture of PVLG and Melzer's reagent were deposited at LPS (La Plata, Spegazzini) herbarium.

Results

Nineteen species belonging to *Acaulosporaceae* were identified. Twelve spore morphotypes could be unequivocally assigned to species of *Acaulospora*, of which one was found to be a new species and six spore types could not be identified to species level.

Taxonomy

1. ***Acaulospora bireticulata*** F.M. Rothwell & Trappe,
Mycotaxon 8: 472. 1979 Figs. 1-2

Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* VIII-2004, *Velázquez.* Isolated from soil sample coming from scrubland, marsh, palm forest, grassland and pot cultures associated with *L. perenne, M. sativa* and *P. lanceolata.* LPS, slide N° 47994.

Distribution and habitat: *A. bireticulata* has a worldwide distribution. Rothwell & Trappe (1979) originally recovered spores of this species from soil sample collected under *Sassafras albidum* growing in Kentucky. Miller et al. (1985) isolated this fungus from the root zone of *Malus domestica* in Michigan. Błaszkowski (1989, 1997) reported it in Poland. Lugo & Cabello (1999) in autochthonous mountain grassland in Central Argentina and Schalamuk et al. (2006) also reported it for agroecosystems associated with wheat crops.

General notes: This material agreed with the original descriptions of *A. bireticulata.*

2. ***Acaulospora delicata*** C. Walker, C. M. Pfeiffer & Bloss,
Mycotaxon 25: 622. 1986

Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* V-2004, *Velázquez.* Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest and pot cultures associated with *L. perenne, M. sativa* and *P. lanceolata.* LPS, slide N° 47995.

Distribution and habitat: *A. delicata* has been cited from *Celtis tala* and *Scutia buxifolia* forests in Argentina (Irrazabal et al. 2004) and from a wheat monoculture (Schalamuk et al. 2006).

General notes: This material agreed with the original descriptions of *A. delicata.*

3. ***Acaulospora denticulata*** E. Sieverd. & Toro,
Angewandte Botanik 61: 217. 1987 Fig. 3

Spores single in the soil, and laterally on the neck of a sporiferous saccule, pale orange-brown to dark orange-brown, globose to subglobose; 120-180 µm diam.

Subcellular structure of spores consists of 3 spore walls and 2 inner germinal walls.

Spore wall composed of 3 layers *(swl*1-3*)*. *Layer 1 (swl*1*)* hyaline, 0.6-1.5 µm thick, and sloughing detached from sporiferous saccule. *Layer 2 (swl2)* 0.6-0.8 µm thick, with stubby yellow-brown "knobs" attached. Circular to oblong projections arise from the "knobs" and have a smooth outer edge or form a polygon of 6 sides, each projection has a central cavity. *Layer 3 (swl3)* a single hyaline layer, <0.8 μm thick, which is detectable only when it separates from the spore wall.

Germinal wall 1 *(gw1)* formed by 2 layers *gw1l1* 0.4-0.6 μm thick and *gw1l2* 1.2-1.4 μm thick. This wall is clearly visible because it separates readily from the spore wall.

Germinal wall 2 *(gw2)* consists of 2 adherent layers. *Layer 1 (gw2l1)* 0.6-1.0 μm thick, with granular excresences. *Layer 2 (gw2l2)* "amorphous" 3-10 μm thick in PVLG, staining red-purple to dark red-purple in Melzer's reagent.

Sporiferous saccule hyaline, mostly globose, 130-160 μm diam.

Cicatrix not observed.

Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park*. IX-2004, *Velázquez*. LPS, slide N° 47996.

Distribution and habitat: *A. denticulata* was isolated from soil collected in Cauca, Colombia (Sieverding & Toro 1987). *A. denticulata* was found associated with woody and herbaceous vegetation in soils of El Palmar National Park. *A. denticulata* was found in soil samples emerging from 4 treatments, scrubland, marsh, palm forest and gallery forest. The spore density of *A. denticulata* in soil samples was 2-4 in 100 g dry soil. The fungi accompanying *A. denticulata* were *Glomus etunicatum* W. N. Becker & Gerd. and *Glomus sp*.

Mycorrhizal associations: *A. denticulata* was associated with woody and herbaceous vegetation.

General notes: *A. denticulata* was not recovered in trap culture. *A. denticulata* was reported by Menendez et al. (2001) in natural and cultivated grasslands in Argentina. However, this species seemed to be *Entrophospora infrequens* (I. R. Hall) R. N. Ames & R. W. Schneid. rather than *A. denticulata* as shown in the figure.

4. Acaulospora dilatata J. B. Morton, Mycologia 78: 641. 1986 Figs. 4-5

Spores single in the soil, and laterally on the neck of a sporiferous saccule, pale yellow to brown, mostly globose to subglobose; 100-130 μm diam.

Subcellular structure of spores consists of 1 spore wall and 2 inner germinal walls.

Spore wall composed of 3 layers *(swl1-3)*. *Layer 1 (swl1)* hyaline, <0.5 μm thick, and sloughing, showing a clear detachment from the sporiferous saccule. *Layer 2 (swl2)* laminate, smooth, pale yellow-brown, 2.8-5.5 μm thick. At maturity, the pore between spore and saccule neck is closed by continuous sublayers of this layer, sealing in spore contents. *Layer 3 (swl3)* pale yellow-brown, 1-4 μm thick, and somewhat flexible when it is separated from layer 2 of the spore wall. This layer also appears to have sublayers (laminae) which can separate more readily from each other than those of layer 2, forming folds that resemble numerous separate “inner walls”.

Germinal wall 1 *(gw1)* 2-layered hyaline wall that separates easily from the spore wall and thus it can be seen readily. Layers separate slightly in many spores but they can also be adherent and appear as a single layer. *Layer 1 (gw1l1)* <0.5 µm thick, folding slightly when separated from layer 2. *Layer 2 (gw1l2)* 0.5-1.0 µm thick. This wall has some inherent rigidity because it breaks with the spore wall.

Germinal wall 2 *(gw2)* consists of 2 adherent hyaline layers. *Layer 1 (gw2l1)* 0.5-1.2 µm thick, presents granular excrescences. *Layer 2 (gw2l2)* plastic, amorphous, 1.0 µm thick, becoming red purple to dark red purple in Melzer’s reagent.

Sporiferous saccule hyaline, mostly globose to subglobose, occasionally irregular, 100-135 µm diam. Saccule wall consist of 1 layer with smooth surface, 1.0-1.4 µm thick.

Cicatrix very narrow lip circumscribing the scar, circular to oval-shaped.

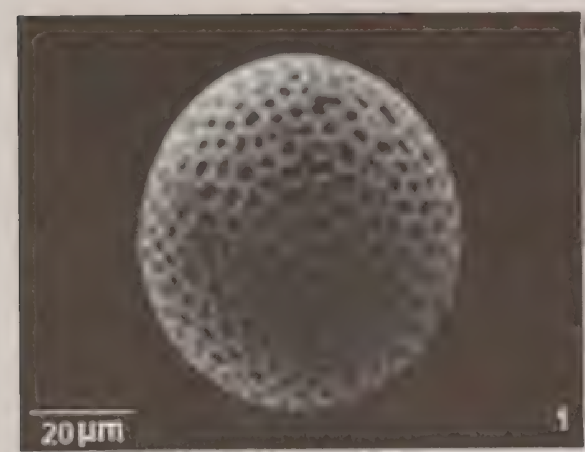
> Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* V-2004, *Velázquez.* LPS, slide N° 47997.

Distribution and habitat: *A. dilatata* was found in 2 coal minesoils in Preston; also on a roadside embankment with acid mine drainage near Sabraton (Morton 1986). *A. dilatata* was found associated with woody and herbaceous vegetation in soils of El Palmar National Park. *A. dilatata* was found in soil samples and trap cultures from 5 treatments, scrubland, marsh, palm forest, grassland, and gallery forest. The spore density of *A. dilatata* in soil samples was 44-156 in 100 g dry soil, the gallery forest evidenced the highest density, whereas in trap culture was 3-21 in 100 g dry soil. The fungi accompanying *A. dilatata* were *G. etunicatum* and *Glomus sp.*

Mycorrhizal associations: *A. dilatata* was associated with woody and herbaceous vegetation and trap cultures with *L. perenne, M. sativa,* and *P. lanceolata.*

General notes: *A. dilatata* spores resembled *Acaulospora lacunosa* J.B. Morton in colour, size and shape, but *A. lacunosa* presented a distinctive ornamentation in the external wall.

Figures 1-2. *Acaulospora bireticulata.* **Fig. 1.** Mature spore. Scanning electron microscopy. **Fig. 2.** Ornamented wall. Scanning electron microscopy. **Figure 3.** *A. denticulata,* ornamented wall. **Figures 4-5.** *A. dilatata.* **Fig. 4.** Mature spore with cicatrix. **Fig. 5.** Broken spores with 3-layered spore wall (*swl*1-3), and 2 inner germinal walls (*gw*1*l*1-2 and *gw*2*l*1-2). *Gw*2*l*2 becoming red purple to dark red purple in Melzer’s reagent. **Figures 6-8.** *A. elegans.* **Fig. 6.** Mature spore with cicatrix. Scanning electron microscopy. **Fig. 7.** Broken spores with 2-layered spore wall (*swl*1-2), and 2 inner germinal walls (*gw*1*l*1-2 and *gw*2*l*1-2). **Fig. 8.** Bilayered germinal wall 2 (*gw*2*l*1-2) with granular excrescences.


20 µm
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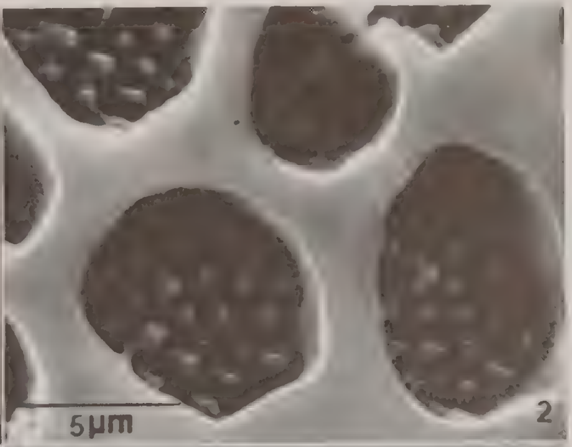
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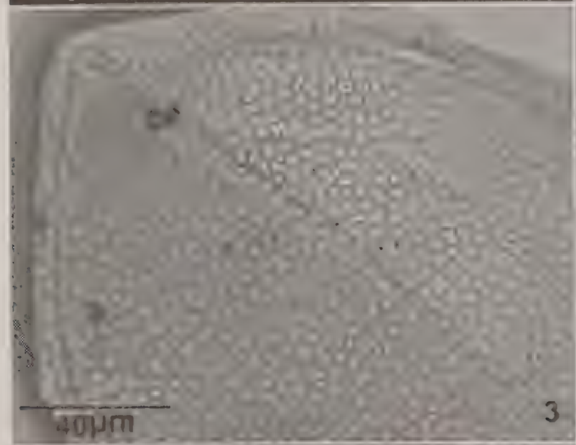
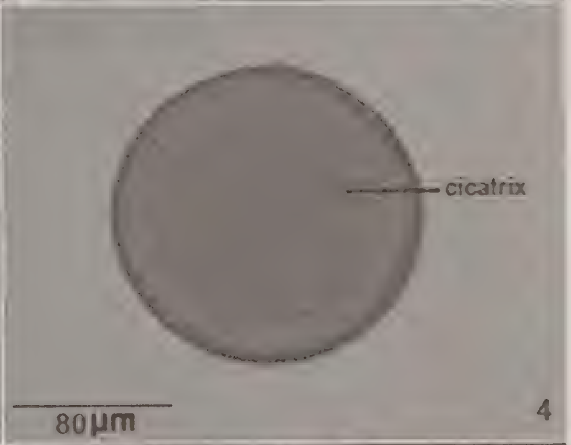
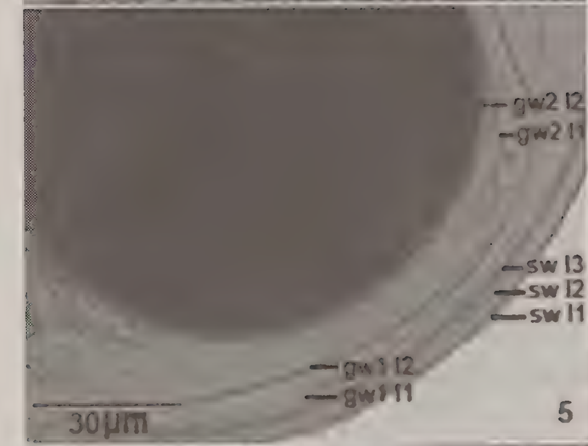
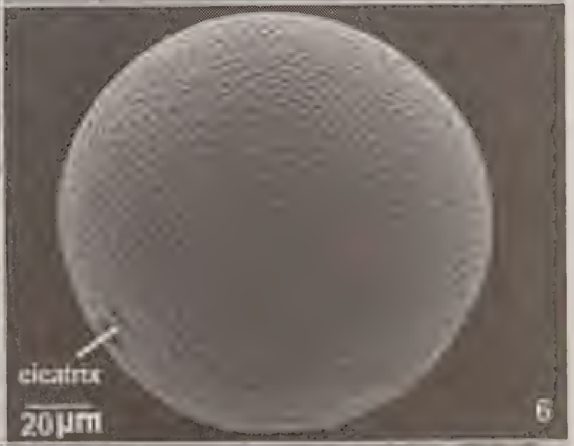
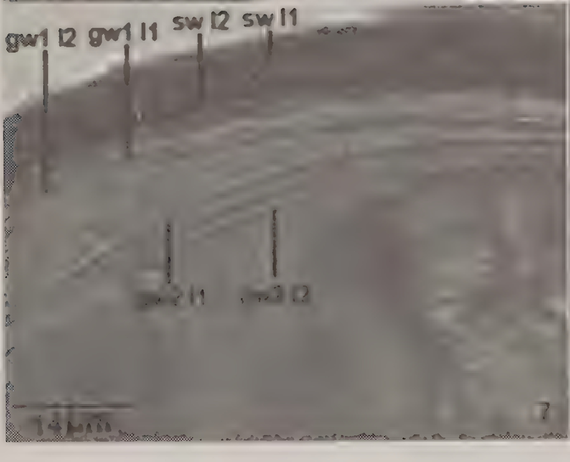
2

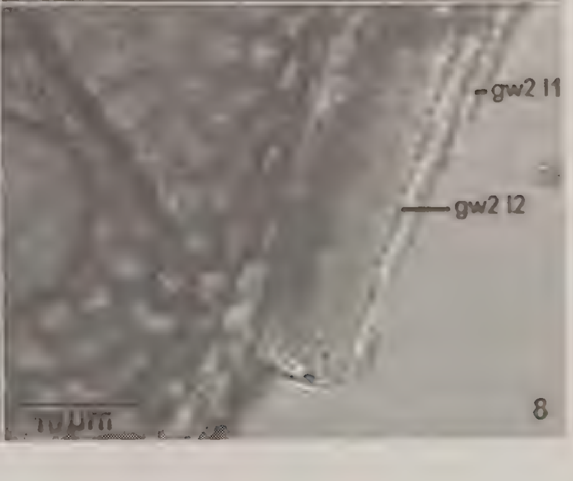

40 µm
3


cicatrix
80 µm
4


gw2 l2
gw2 l1
sw l3
sw l2
sw l1
gw1 l2
gw1 l1
30 µm
5


cicatrix
20 µm
6


gw1 l2
gw1 l1
sw l2
sw l1
gw2 l1
gw2 l2
14 µm
7


gw2 l1
gw2 l2
10 µm
8

5. *Acaulospora elegans* J.W. Trappe & Gerd.,
Mycologia Memoir 5: 34. 1974 FIGS. 6-7-8

SPORES single in the soil, and laterally from the neck of a sporiferous saccule. Dark brown, globose to subglobose; 140-280 x 145-330 μm diam.

SUBCELLULAR STRUCTURE OF SPORES consists of 1 spore wall and 2 inner germinal walls.

SPORE WALL composed of 2 layers *(swl1-2)*. *LAYER 1 (swl1)* hyaline, continuous with the wall of the hyphal neck subtending the saccule. *LAYER 2 (swl2)* consisting of laminae within which spines are crowded. Light brown spines 2.0 μm wide x 0.5 μm high, with total layer as much as 12 μm. An alveolate reticulum of hyaline ridges is superimposed on the spines. Alveoli are 4-8 μm long.

GERMINAL WALL 1 *(gw1)* consists of 2 thin adherent flexible layers *(gw1l1-2)*, which almost appear to be of equal thickness, presenting granular excresenses.

GERMINAL WALL 2 *(gw2)* consists of 2 hyaline layers *(gw2l1-2)*, granular excresenses, the outher layer thinner than the inner 1, which produces a red–brown reaction in Melzer's reagent.

SPORIFEROUS SACCULE pale brown, mostly globose to ellipsoid, 150-240 μm diam.

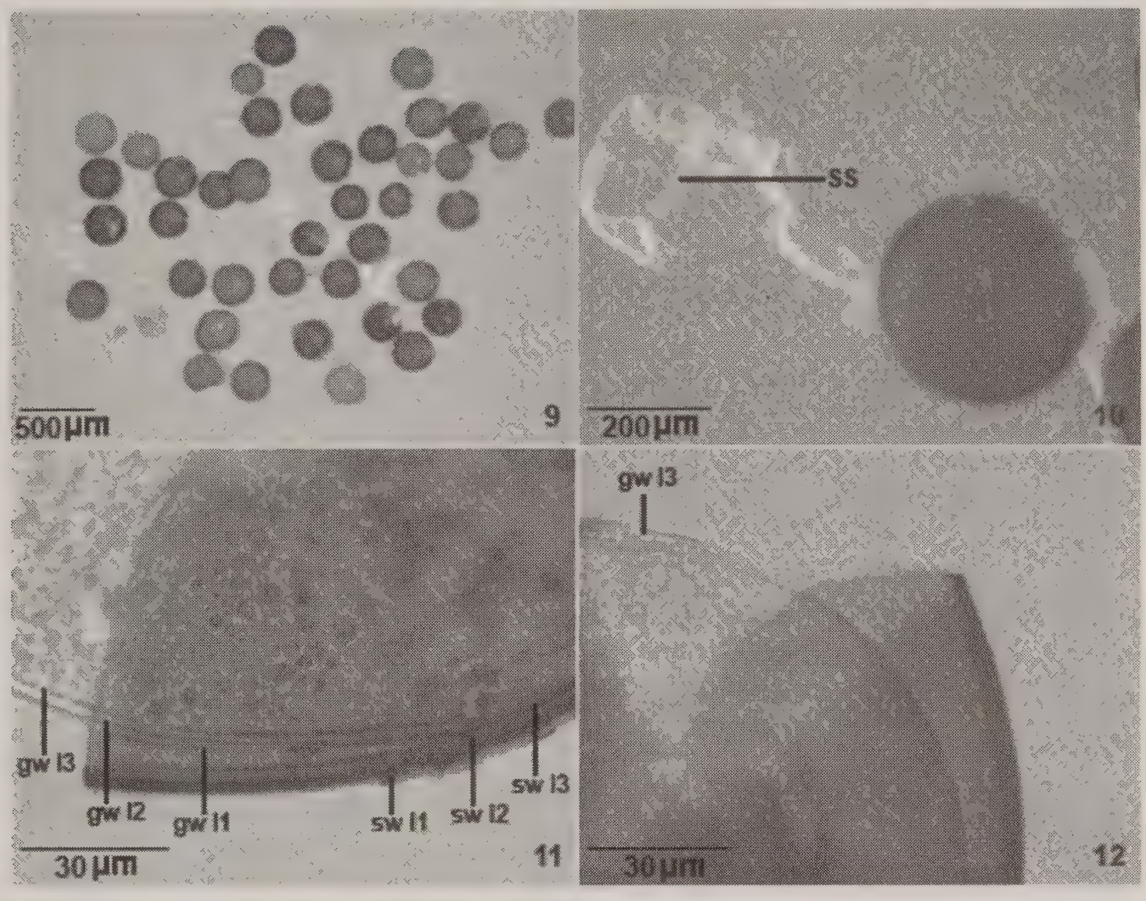
CICATRIX not observed.

MATERIAL EXAMINED: ARGENTINA. Entre Ríos: *El Palmar National Park*. XI-2006, *Velázquez*. LPS, slide N° 47998.

DISTRIBUTION AND HABITAT: *A. elegans* has a widely distributed in coastal sands of northern California to southwestern Washington (Gerdemann & Trappe 1974). *A. elegans* was found in trap cultures containing soil from marsh of El Palmar National Park. The spore density of *A. elegans* in trap culture was 53 in 100 g dry soil. The fungus accompanying *A. elegans* was *G. etunicatum*.

MYCORRHIZAL ASSOCIATIONS: *A. elegans* was associated in trap cultures with *L. perenne*, *M. sativa* and *P. lanceolata*.

GENERAL NOTES: spores of *A. elegans* resembled *A. bireticulata* except for pattern of ornamentation in layer 2 (swl2) of the spore wall. Gerdemann & Trappe (1974) described the spore wall as a 3-layered reticulum over "angular processes" 1 μm high, whereas the spore wall of *A. elegans* was described as a single–layered reticulum over crowded spines only 0.5 μm high. Therefore, concerning these differences these species would be considered as separate. The germinal wall ornamentation in El Palmar National Park *A. elegans* spores is quite different from that characterized by INVAM. Spores found in El Palmar exhibited granular excresences in 2 germinal walls (*gw*1-2) whereas INVAM spores are only in *gw2l2*.



Figures 9-12. *Acaulospora entreriana.* **Figure 9.** Spores. **Figure 10.** Spore laterally on the neck of a sporiferous saccule (ss). **Figure 11.** Broken spores with 3-layered spore wall (*swl*1-3) and 3-layered germinal wall (*gwl*1-3). **Figure 12.** Broken spores with *gwl*3 ornamented with teeth.

6. *Acaulospora entreriana* M.S. Velázquez & Cabello, **sp. nov.** Figs. 9–12

MycoBank MB 511190

Sporae singulare in solo efformtae, lateraliter gestae ad collum sacculi sporangiferi; brunneae, globosae, subglobosae vel ovoideae 260-300 x 280-330 µm diam. Sacculus sporifer hyalinus, globosus vel subglobosus, aliquando irregularis 240-280 µm diam. Sporae tunicis doubus, tunica exterior et interior. Tunica exterior in totum 4,5 µm crassa, stratis tribus: stratum exterius tenue et evanescens, hyalinum; stratum medium laminatum, brunneum; stratus interius hyalinum. Tunica interior stratis tribus 3,6 µm in totum, hyalina, stratis uno hyalino minutis granulatis; stratis duobus hyalino; stratis tribus conspicue dentata, dentibus 0,5µm longis. Formans vesicular-arbuscular mycorrhizae.

ETYMOLOGY: *entreriana,* referring to Entre Ríos Province where the species was first found.

TYPUS: isolated from trap culture at the Institute of Botany Spegazzini, Universidad Nacional de La Plata, Argentina. XI-2006, *Velázquez.* Holotypus LPS, slide N° 47993.

SPORES single in the soil, and laterally on the neck of a sporiferous saccule, brown, globose to subglobose; 280-300 µm diam, sometimes ovoid; 260–300 x 280-330 µm.

SUBCELLULAR STRUCTURE OF SPORES consists of 1 spore wall and inner germinal wall. Neither spore nor germinal walls react in Melzer's reagent.

Spore wall composed of 3 layers *(swl1-3)*, 4.5 µm thick. *Layer 1 (swl1)* evanescent, hyaline, 0.9 µm thick, rarely present in mature spores, continuous with the wall of a soporiferous saccule. *Layer 2 (swl2)* smooth, light brown to dark brown, (1.2-)2.7(-4.6) µm thick. *Layer 3 (swl3)* smooth, composed of 3–4 tightly attached laminae, hyaline, (0.7)1.0(-2.7) µm thick, commonly adhered to layer 2.

Germinal wall 3-layered, hyaline, *(gwl1-3)* 3.6 µm thick. *Layer 1 (gwl1)* smooth, hyaline, covered with small beads, (0.7-)2.7(-1.2) µm thick. *Layer 2 (gwl2)* smooth hyaline. *Layer 3 (gwl3)* hyaline 0.9-1.5 µm thick in PVLG, ornamented with teeth 0.5 µm high.

Sporiferous saccule hyaline, mostly globose to subglobose, occasionally irregular, 240-280 µm diam. Distance from saccule to spore 100-150 µm.

Cicatrix not observed.

Distribution and habitat: *A. entreriana* was found in trap cultures built up with soil from scrubland, palm forest, grassland, and gallery forest of El Palmar National Park. The spore density of *A. entreriana* in trap culture was 4-200 in 100 g dry soil, the scrubland evidenced the highest density. The fungi accompanying *A. entreriana* were *A. delicata, E. infrequens, Glomus claroideum* N. C. Schenck & G. S. Sm. and *G. etunicatum*.

Mycorrhizal associations: Forms vesicular arbuscular mycorrhizae. *A. entreriana* was associated in trap cultures with *L. perenne, M. sativa* and *P. lanceolata*.

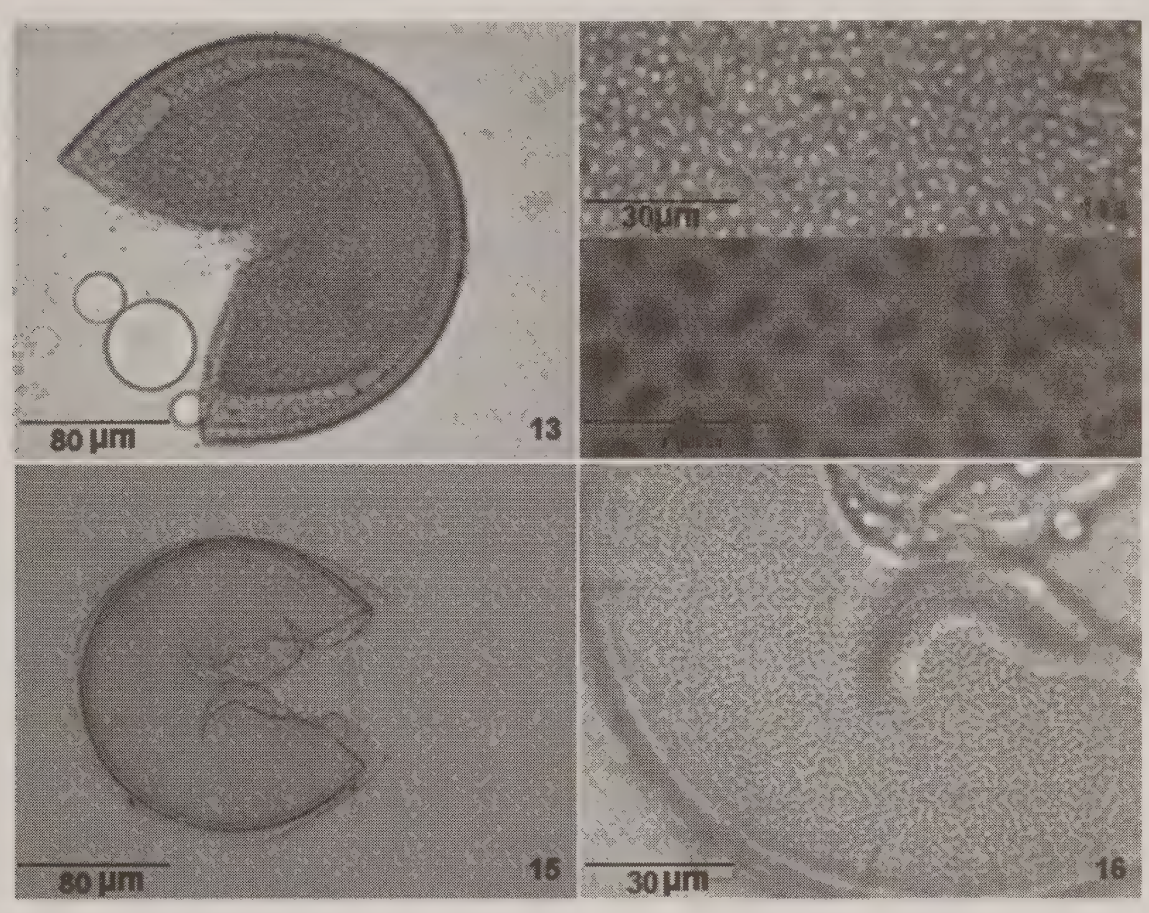
General notes: In colour and shape, *A. entreriana* spores resemble those of *Acaulospora koskei* J. Błaszk. (Błaszkowski 1995), except larger and with an ornamented inner wall. The wall in *A. entreriana* did not react in Melzer's, whereas the smooth wall of *A. koskei* turned red-purple in the same reagent. Both *A. entreriana* and *A. splendida* E. Sieverd. et al. are the only species known in *Acaulospora* that have a single germinal wall, a character that is very important considering that germinal walls are involved in germination. *A. entreriana* walls do not react in Melzer reagent, a character shared with *A. polonica* J. Błaszk.

A. entreriana spores were not recovered in soil samples.

7. ***Acaulospora excavata*** Ingleby & C. Walker, Mycotaxon 50: 100. 1994

> Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* VIII-2004, *Velázquez.* Isolated from soil sample from scrubland, marsh and palm forest. LPS, slide N° 47999.

Distribution and habitat: this species was found for the first time at Ivory Coast, Africa. Later it was found in Central Argentina mountain grasslands (Lugo & Cabello 1999) and agroecosystems (Schalamuk et al. 2006).



Figures 13-14. *Acaulospora foveata.* **Figure 13.** Mature spore in Melzer's reagent. **Figure 14 a-b.** Ornamented wall. **Figures 15-16.** *A. rehmii.* **Figure 15.** Broken spores. **Figure 16.** Broken spores with labyrinthiform ornamentation.

General notes: This species was not recovered on trap plants. This material agrees with the original descriptions of *A. excavata.*

8. ***Acaulospora foveata*** J. M. Trappe & Janos,

Mycotaxon 15: 516. 1982 Figs. 13-14 a, b

Spores single in the soil, and laterally on the neck of a sporiferous saccule, red-orange to dark red-orange, globose to subglobose; 240-320 µm diam.

Subcellular structure of spores consists of 1 spore wall and 2 inner germinal walls.

Spore wall composed of 3 layers *(swl1-3)*. *Layer 1 (swl1)* hyaline, 2.0 µm thick, rarely present in mature spores. *Layer 2 (swl2)* 9-18 µm thick at maturity. Initially a single layer, forms in undulations that establish the shape and depth of surface concave circular to ovoid depressions (8-12 µm across and 0.5-3 µm deep in the mature layer). *Layer 3 (swl3)* 3-5 µm thick, produces a dark red-brown reaction in Melzer's reagent.

Germinal wall 1 *(gw1)* consists of 2 adherent layers *(gw1l1-2)*, both are of near-equal thickness, ranging from 0-6-1.0 µm thick.

Germinal wall 2 *(gw2)* consists of 2 adherent layers *(gw2l1-2)*, produces pinkish red to a reddish-purple reaction in Melzer's reagent.

Sporiferous saccule not observed.

Cicatrix not observed.

> Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* VIII-2007, *Velázquez.* LPS, slide N° 48000.

Distribution and habitat: *A. foveata* was found in wet tropical forests in Mexico, Costa Rica and Panama (Janos & Trappe 1982). *A. foveata* was found in trap cultures built up with soil from palm forest of El Palmar National Park. The spore density of *A. foveata* in trap culture was 6 in 100 g dry soil. The fungi accompanying *A. foveata* were *A. delicata* and *G. etunicatum.*

Mycorrhizal associations: *A. foveata* was associated in trap cultures with *L. perenne, M. sativa* and *P. lanceolata.*

General notes: *A. foveata* spores were not recovered in soil samples. This material agreed with the original descriptions of *A. foveata.*

9. Acaulospora laevis J. W. Gerd. & Trappe, Mycologia Memoir 5: 33. 1974

> Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* V-2004, *Velázquez.* Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest. LPS, slide N° 48001.

Distribution and habitat: *A. laevis* has a worldwide distribution. Abundant from the coast of northern California to Washington. Also reported from Florida, Australia, New Zeland, Pakistan and Scotland. *A. laevis* was found associated with mountain grasses in Central Argentina (Lugo et al. 1999) and with *C. tala* and *S. buxifolia* forests (Irrazabal et al. 2004).

General notes: *A. laevis* spores were not recovered on trap plants.

10. Acaulospora mellea Spain & N. C. Schenck, Mycologia 76: 689. 1984

> Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* V-2004, *Velázquez* Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest and pot cultures associated with *L. perenne, M. sativa* and *P. lanceolata.* LPS, slide N° 48002.

Distribution and habitat: *A. mellea* was found in Poland in uncultivated and cultivated soils (Błaszkowski 1993) and associated with dune plants (Błaszkowski et al. 2002). In Central Argentina, it was found associated with mountain grassland (Lugo & Cabello 1999) and agroecosystems (Schalamuk et al. 2006).

General notes: Our material agreed with the original descriptions of *A. mellea.*

11. Acaulospora rehmii Sieverd. & S. Toro,
Angewandte Botanik 61: 219. 1987 Figs. 15-16

Spores single in the soil, and laterally on the neck of a sporiferous saccule, pale yellow to light brown, globose to subglobose 90-160 μm diam.

Subcellular structure of spores consists of 1 spore wall and 2 inner germinal walls.

Spore wall composed of 3 layers *(swl1–3)*. *Layer 1 (swl1)* evanescent, hyaline, 1.0 μm thick, continuous with the wall of a sporiferous saccule, rarely present in mature spores. *Layer 2 (swl2)* laminate, pale yellow, 4-10 μm thick, ornamented with labyrinthiform folds. *Layer 3 (swl3)* semiflexible, hyaline, 0.5 μm thick, rarely separated from layer 2.

Germinal wall 1 *(gw1)* consists of 2 tightly adherent hyaline, semiflexible layers. *Layer 1 (gw1l1)* and *layer 2 (gw1l2)* reach 0.5-1.0 μm thick. These layers tightly adhere to each other and hence are quite difficult to differentiate.

Germinal wall 2 (gw2) composed of 2 adherent layers. *Layer 1 (gw2l1)* flexible, hyaline, 0.5-1.0 μm thick, covered with granules. *Layer 2 (gw2l2)* flexible, hyaline, 0.6-1.4 μm thick in PVLG.

Sporiferous saccule hyaline, globose to subglobose, 90-150 μm diam, usually collapsed and detached in mature spores.

Cicatrix not observed.

Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* IX-2006, *Velázquez.* LPS, slide N° 48003.

Distribution and habitat: *A. rehmii* was originally isolated from a crop field at Caicedonia, Valle de Cauca, Colombia (Sieverding & Toro 1987). This fungus has been associated with cassava, beans, sorghum and *Crotalaria* species. Additionally, Sieverding & Toro (1987) found *A. rehmii* spores in a culture containing a soil sample from Brasilia, Brazil. Wu et al. (1995) isolated *A. rehmii* spores from among roots of *Phyllostachys pubescens* growing in a garden at Chitou Experimental Station, National Taiwan University.

A. rehmii was found in trap cultures containing soil from the El Palmar National Park palm forest. Its trap culture spore density was 6 per 100 g dry soil. The fungi accompanying *A. rehmii* were *G. etunicatum* and *Glomus sp.*

Mycorrhizal association: *A. rehmii* was associated in trap cultures with *L. perenne, M. sativa* and *P. lanceolata.*

General notes: *A. rehmii* is a species easily recognized by the unique labyrinthiform ornamentation of its layer 2 spore wall.

*12. **Acaulospora scrobiculata*** J. M. Trappe, Mycotaxon 6: 363. 1977

> Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* V-2004, *Velázquez.* Isolated from soil sample from scrubland, marsh, palm forest, grassland and gallery forest and trap cultures associated with *L. perenne, M. sativa* and *P. lanceolata.* LPS, slide N° 48004.

Distribution and habitat: *A. scrobiculata* was originally described from spores collected in Mexico (Trappe 1977). This fungus has a global distribution and is found in many localities in the U.S.A. (Friese & Koske 1991, Gemma & Koske 1989, Koske 1987, 1988), Canada (Dalpé 1989), Australia (Koske 1975), China (Zhang et al. 1992), Taiwan (Wu & Chen 1986), and Argentina (Lugo & Cabello 1999).

General notes: The spores of our material correspond in colour, form and size with those originally described.

*13. **Acaulospora spinosa*** C. Walker & Trappe, Mycotaxon 12: 515. 1981

> Material examined: ARGENTINA. Entre Ríos: *El Palmar National Park.* V-2004, *Velázquez.* Isolated the soil sample from scrubland, marsh, palm forest, grassland and gallery forest. LPS, slide N° 48005.

Distribution and habitat: This fungus has a worldwide distribution and is found in many localities in the U.S.A. and Mexico. *A. spinosa* was found in a mountain grassland in Central Argentina (Lugo & Cabello 1999). Irrazabal et al. (2004) also record it from *C. tala* and *S. buxifolia* forests.

General notes: *A. spinosa* spores were not recovered in trap plants.

Discussion

These species of *Acaulosporaceae* were identified in field samples and in trap culture; a total of 19 species were detected in El Palmar National Park. *Acaulospora* diversity in El Palmar National Park was found to be higher than that reported for other ecosystems (Lugo & Cabello 1999, 2002, Lugo et al. 1999, Irrazabal et al. 2004) or agroecosystems (Albornoz & Catania 1996, Menéndez et al. 2001, Schalamuk et al. 2006) in Argentina. AM fungal communities dominated by *Acaulospora* spp. have been reported in other forested ecosystems (Helgason et al. 1998, Merryweather & Fitter 1998a, b), and in alluvial soils (Lovelock et al. 2003).

The decrease of anthropoid disturbance in protected areas such as El Palmar National Park is well known to markedly favour diversity conservation (Jasper et al. 1991). On the other hand, heterogeneity of the environment involving scrubland, marsh, palm forest grassland and gallery forest play an essential role in keeping the abundance and distribution of these fungi.

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Literature cited

Albornoz P, Catania M. 1996. Endomicorriza y cultivo de soja y maíz en el Este tucumano (Argentina). Influencia de los diferentes sistemas de labranza. Boletín de la Sociedad Argentina de Botánica 31: 17-20.

APN: Administración Parques Nacionales. 1994. El Sistema Nacional de Áreas Naturales Protegidas de la República Argentina. Diagnóstico para su Desarrollo Institucional y Patrimonio Natural. Administración de Parques Nacionales. Argentina.

Berch SM. 1985. *Acaulospora sporocarpia*, a new sporocarpic species, and emendation of the genus *Acaulospora* (*Endogonaceae, Zygomycotina*). Mycotaxon 23: 409-418.

Biganzoli F, Batista WB, Burkart SE, Goveto L, Maranta A. 2001. La diversidad florística del Parque Nacional El Palmar: contribución de diferentes ambientes de sabana. 1ra Reunión Binacional Argentino-Chilena de Ecología, XX Reunión Argentina de Ecología y X Reunión de la Sociedad de Ecología de Chile, San Carlos de Bariloche, Argentina.

Błaszkowski J. 1989. Polish *Endogonaceae* 1. *Acaulospora bireticulata, Entrophospora infrequens, Glomus caledonium* and *Scutellospora pellucida.* Karstenia 29: 1-10.

Błaszkowski J. 1993. Comparative studies of the occurrence of arbuscular fungi and mycorrhizae (*Glomales*) in cultivated and uncultivated soils of Poland. Acta Mycologica 28: 93-140.

Błaszkowski J. 1995. *Acaulospora koskei*, a new species in *Glomales* from Poland. Mycological Research 99: 237-240.

Błaszkowski J. 1997. Notes on *Acaulospora bireticulata* (*Glomales, Zygomycetes*) found in Poland. Mycotaxon 61: 193-204.

Błaszkowski J, Tadych M, Madej T. 2002. Arbuscular mycorrhizal fungi (*Glomales, Zygomycota*) of the Bledowska Desert, Poland. Acta Societatis Botanicorum Poloniae 71: 71-85.

Brundrett M, Melville L, Peterson L. 1994. Practical Methods in Mycorrhizal Research. Mycologue Publications. Univ. of Guelph, Guelph, Notario, Canada.

Cabello MN. 1997. Hydrocarbon pollution: its effect on native arbuscular mycorrhizal fungi (AMF). FEMS Microbiology Ecology 22: 233-236.

Cavalier-Smith T. 1988. A revised six-kingdom system of life. Biological Reviews 73: 203-266.

Dalpé Y. 1989. Inventarie et repartition de la flore endomycorrhizine de dunes et de riveges maritime du Québec, du Nouveau-Brunswick et de la Nouvelle-Ecosse. Naturaliste Can (Rev Ecol Syst) 116: 219-236.

Friese CF, Koske RE. 1991. The spatial dispersion of spores of vesicular arbuscular mycorrhizal fungi in a sand dune: microscale patterns associated with the root architecture of American beachgrass. Mycological Research 95: 952-957.

Gemma JN, Koske RE. 1989. Field inoculation of American beachgrass (*Ammophila breviligulata*) with V-A mycorrhizal fungi. Journal Environment Management 29: 173-182.

Gerdemann JW, Nicolson TH. 1963. Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. Transactions of the British Mycological Society 46: 235-244.

Gerdemann JW, Trappe JM. 1974. The *Endogonaceae* in the Pacific Northwest. Mycologia Memoir 5: 1-76.

Harley JL, Smith SE. 1983. Mycorrhizal Symbiosis. Academic Press: London, U.K.

Hawksworth DL. 1991. The fungal dimension of biodiversity: Magnitude, significance, and conservation. Mycological Research 95: 641-655.

Helgason T, Daniel TJ, Husband R, Fitter A, Young JPY. 1998. Ploughing up the wood-wide web. Nature 394: 431.

Irrazabal G, Velázquez MS, Cabello M. 2004. Infectividad y diversidad de hongos micorrícicos arbusculares de la rizósfera de los talares de Magdalena, provincia de Buenos Aires, Argentina. Boletín Micológico 19: 49-57.

Irrazabal G, Schalamuck S, Velázquez MS, Cabello M. 2005. Especies de hongos formadores de micorrizas arbusculares: Nuevas citas para la República Argentina. Boletín de la Sociedad Argentina de Botánica 40: 17-22.

Janos DP, Trappe JM. 1982. Two new *Acaulospora* species from Tropical America. Mycotaxon 15: 515-522.

Jasper DA, Abbott LK, Robson AD. 1991. The effect of soil disturbace of vesicular-arbuscular mycorrhizal fungi in soil from different vegetation types. New Phytologist 118: 471-476.

Koske RE, Tessier B. 1983. A convenient, permanent slide mounting medium. Mycological Society of America Newsletter Vol 34: 1-59.

Koske RE. 1987. Distribution of VA mycorrhizal fungi along a latitudinal temperature gradient. Mycologia 79: 55-68.

Koske RE. 1988. Vesicular–arbuscular mycorrhizae of some Hawaiian dunes plants. Pacific Science 42: 217-229.

Lovelock CE, Andersen K, Morton JM. 2003. Host tree and environmental control on arbuscular mycorrhizal hyphal growth: an example from a tropical rain forest soil. Soil Biology and Biochemestry 36: 1009-1012.

Lugo MA, Cabello MN. 1999. *Acaulosporaceae* (*Glomales, Zygomycetes*) en pastizales autóctonos del centro de Argentina. II. Darwiniana 37: 323-332.

Lugo MA, Cabello MN. 2002. Native arbuscular mycorrhizal fungi (AMF) from mountain grassland (Cordoba, Argentina) I. Seasonal variation of fungal spore diversity. Mycologia 94: 579-586.

Lugo MA, Cabello MN, Anton AM. 1999. Novedades en Glomales (*Zygomycetes*) de pastizales del centro de Argentina. Kurtziana 27: 391-401.

McGee PA, Smith SE, Smith FA (eds.) 1989. Plant-microbe Interface: Structure and Function. CSIRO: Brown Prior Anderson, Melbourne, Australia.

Menéndez AB, Scervino JM, Godeas AM. 2001. Arbuscular mycorrhizal populations associated with natural and cultivated vegetation on a site of Buenos Aires province, Argentina. Biology and Fertility of Soils 33: 373-381.

Merryweather J, Fitter AH. 1998a. The arbuscular mycorrhizal fungi of *Hyacinthoides non-scripta* I. Diversity of fungal taxa. New Phytologist 138: 117-129.

Merryweather J, Fitter AH. 1998b. The arbuscular mycorrhizal fungi of *Hyacinthoides non-scripta* II. Seasonal and spatial patterns of fungal populations. New Phytologist 138: 131-142.

Miller DD, Domoto PA, Walker C. 1985. Mycorrhizal fungi at eighteen apple rootstock plantings in the United States. New Phytologist 100: 379-391.

Morton JB. 1986. Three new species of *Acaulospora* (*Endogonaceae*) from high aluminium low pH soils in west Virginia. Mycologia 78: 641-648.

Morton JB, Redecker D. 2001. Two new families of *Glomales, Archeosporaceae* and *Paraglomaceae,* with two new genera *Archeospora* and *Paraglomus,* based on concordant molecular and morphological characters. Mycologia 93: 181-195.

Oehl F, Sieverding E, Ineichen K, Mäder P, Boller T, Wiemken A. 2003. Impact of land use intensity on the species diversity of arbuscular mycorrhizal fungi in agroecosystem of Central Europe. Applied Environment Microbiology 69: 2816-2824.

Oehl F, Sýkorová Z, Redecker D, Wiemken A, Sieverding E. 2006. *Acaulospora alpina* a new species in the *Glomeromycetes* characteristic for high montane and alpine regions of the Swiss Alps. Mycologia 98: 286-294.

Redecker D, Morton JB, Bruns TD. 2000. Ancestral lineages of arbuscular mycorrhizal fungi (*Glomales*). Molecular Phylogenetic Evolution 14: 276-284.

Rothwell FM, Trappe JM. 1979. *Acaulospora bireticulata* sp. nov. Mycotaxon 8: 471-475.

Schalamuk S, Velázquez S, Chidichimo H, Cabello M. 2006. Fungal spore diversity of arbuscular mycorrhizal fungi associated with spring wheat: effects of tillage. Mycologia 98: 16-22.

Schüssler A, Schwarzott D, Walker C. 2001. A new fungal phylum, the Glomeromycota: phylogeny and evolution. Mycological Research 105: 1413-1421.

Schüssler A. 2007. http://AMF-phylogeny.com

Sieverding E, Toro ST. 1987. *Acaulospora denticulata* sp. nov. and *Acaulospora rehmii* sp. nov. (*Endogonaceae*) with ornamented spore walls. Angewandte Botanik 61: 217-223.

Stürmer SL, Morton JB. 1999. Taxonomic reinterpretation of morphological characters in *Acaulosporaceae* based on developmental patterns. Mycologia 91: 849-857.

Trappe JW. 1977. Three new Endogonaceae: *Glomus constrictus, Sclerocystis clavispora* and *Acaulospora scrobiculata.* Mycotaxon 6: 359-366.

Walker C, Mize W, McNabb HS. 1982. Populations of endogonaceous fungi at two populations in central Iowa. Canadian Journal of Botany 60: 2518-2529.

Wang B, Qiu Y-L. 2006. Phylogenetic distribution and evolution of micorrizas in land plants. Mycorrhiza 16: 299-363.

Wu C-G, Chen ZC. 1986. The *Endogonaceae* of Taiwan. I. A preliminary investigation on Endogonaceae of bamboo vegetation at Chi-Tou areas, Central Taiwan. Taiwania 31: 65-88.

Wu C-G, Liu Y-S, Hwuang Y-L, Wang Y-P, Chao C-C. 1995. *Glomales* of Taiwan: V. *Glomus chimonobambusae* and *Entrophospora kentinensis,* spp. nov. Mycotaxon 53: 283-294.

Zhang M-Q., Wang Y-S, Huang L. 1992. Eight species of VA mycorrhizal fungi from northern China. Acta Mycological Sin 11: 258-267.

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Hymenoscyphus ginkgonis sp. nov. growing on leaves of *Ginkgo biloba*

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Abstract — An interesting *Hymenoscyphus* species was collected on the leaves of *Ginkgo biloba* in Korea. Morphological characteristics and sequence analysis of the ITS rDNA indicate that the fungus represents a distinct new species, named here as *Hymenoscyphus ginkgonis*.

Key words — *Helotiaceae*, ITS rDNA, sequence analysis, taxonomy

Introduction

Ginkgo biloba L. ("ginkgo tree"), the only extant species within the genus *Ginkgo*, is common in the temperate zone, especially China, Korea and Japan. Since ginkgo tree originated about 200 million years ago, it is often called a living fossil. Some fungal species have been reported as pathogens, saprobes or symbionts of *G. biloba* (Aoki 1997, Fontana 1985, Vasilyeva & Mel'nik 2006), but there have been no records of discomycetous fungi on gingko tree substrate.

During our mycofloristic research in Korea, we collected an apothecial ascomycete growing on fallen leaves of *G. biloba*. The fungus, referred to *Hymenoscyphus* by careful macro- and microscopic observation, did not match any known species in the genus. In this paper we describe this fungus as a new species of *Hymenoscyphus* based on morphological characteristics and sequence analysis of the ITS region (ITS1-5.8S-ITS2) of rDNA.

Materials and methods

Free-hand sections of fresh materials were mounted in distilled water, lactic acid, lacto-cotton blue and Melzer's reagent in case of needs. Dried materials were revived in 3% aqueous KOH. Photographic works were carried out with the aid of a differential interference contrast microscope (Zeiss AX10) equipped

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* *Author for correspondence*

Table 1. Sequence data used for phylogenetic analysis.

Species	Source	Habitat	Accession No.
Hymenoscyphus caudatus (P. Karst.) Dennis	HMAS 82057	Herbaceous stem	AY348576
	HMAS 82060	Unknown	AY348577
	HMAS 82063	Herbaceous stem	AY348578
	HMAS 82073	Herbaceous stem	AY348579
H. crataegi Baral & R. Galan	F156966	Leaves of *Crataegus monogyna*	DQ431177
H. epiphyllus (Pers.) Rehm ex Kauffman	HMAS 82075	Fallen leaves	AY348580
	HMAS 82076	Unknown	AY348581
	H.B.7054	Bark of *Quercus* sp.	DQ431180
H. fructigenus (Bull.) Fr.	ARON3264.H	Decaying nut of *Quercus robur*	AJ430396
	F109077	Unknown	DQ431169
	F115882	Fruits of *Quercus robur*	DQ431171
	F156965	Twigs of *Abies* sp.	DQ431176
H. fucatus (W. Phillips) Baral	HMAS 75902	Unknown	AY348583
Hymenoscyphus sp.	KUS-F51352	Fallen leaves of *Ginkgo biloba*	EU096525*
	KUS-F51854	Fallen leaves of *Ginkgo biloba*	EU219982*
H. globus W.Y. Zhuang & Yan H. Zhang	HMAS 82107	Wet hardwood	AY348593
H. immutabilis (Fuckel) Dennis	HMAS 71809	Rotten leaves of *Populus* sp.	AY348584
	F137632	Leaves of *Ulmus* sp.	DQ431174
	F155012	Decayed leaves of *Salix caprea*	DQ431175
H. lasiopodius (Pat.) Dennis	HMAS 71820	Dead root of *Carex* sp.	AY348585
	HMAS 71821	Dead root of *Carex* sp.	AY348586
	HMAS 75878	Dead root of *Carex* sp.	AY348587
H. macroguttatus Baral, B. Declereq & Hengstm	H.B. 7034	Leaves of *Acer pseudoplatanus*	DQ431179
H. scutula (Pers.) W. Phillips	HMAS 82093	Fern	AY348590
	HMAS 82098	Herbaceous stem	AY348591
H. serotinus (Pers.) W. Phillips	F093261	Rotten wood of *Fagus sylvatica*	DQ431168
	F115891	Branches of *Fagus sylvatica*	DQ431173
	F159526	*Fagus sylvatica*	DQ431178
	BR020	*Tamarix gallica* debris	DQ431167
Lachnum virgineum (Batsch) P. Karst.	AFTOL-ID 49	Unknown	DQ491485

* Sequences obtained from the present study.

with a digital camera (AxioCam MRc5). The specimens were deposited in the herbarium of Korea University, KUS.

Extraction of genomic DNA was undertaken according to the method outlined by Lee & Taylor (1990). The entire ITS region was amplified by PCR using primers ITS1 and ITS4 (White et al. 1990) and purified using a QIAquick gel extraction kit (Qiagene, Hilden, Germany). And then the products were directly sequenced on an automatic sequencer (ABI Prism TM 377 DNA Sequencer) with primers identical for PCR. Sequence data were introduced and edited with DNAstar (DNAstar, Inc., Madison, Wis.). To construct a tree twenty-eight sequences were obtained from GenBank and compared with the present fungus (listed in Table 1). Phylogenetic analysis was performed using the neighbor-joining method (Saitou & Nei 1987) in PAUP* ver. 4b10 (Swofford 2002). Relative robustness of the branches was estimated by bootstrapping of 1000 replication. *Lachnum virgineum* (Batsch) P. Karst. (DQ491485), member of the *Hyaloscyphaceae* was selected as outgroup for analysis.

Results and discussion

The *Hymenoscyphus* species we collected is characterized by its yellowish apothecia with a long stipe, elliptic-clavate ascospores and paraphyses with a deep violet apex. In a mixed pile of fallen leaves, the fruiting bodies of this fungus were found only on the leaves of ginkgo tree, and not on other substrate

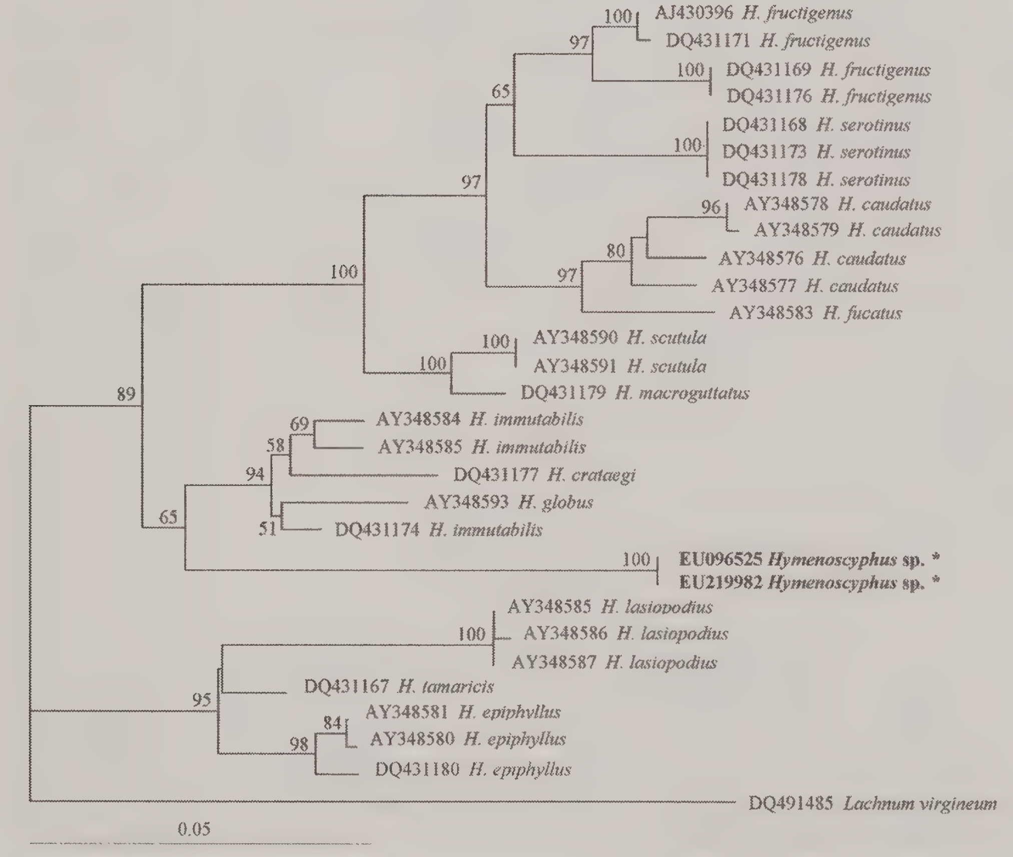
100
AJ430396 H. fructigenus
97
DQ431171 H. fructigenus
100
DQ431169 H. fructigenus
DQ431176 H. fructigenus
65
DQ431168 H. serotinus
100
DQ431173 H. serotinus
97
DQ431178 H. serotinus
96
AY348578 H. caudatus
AY348579 H. caudatus
80
AY348576 H. caudatus
100
97
AY348577 H. caudatus
AY348583 H. fucatus
100
AY348590 H. scutula
100
AY348591 H. scutula
89
DQ431179 H. macroguttatus
69
AY348584 H. immutabilis
58
AY348585 H. immutabilis
94
DQ431177 H. crataegi
AY348593 H. globus
65
51
DQ431174 H. immutabilis
100
EU096525 Hymenoscyphus sp. *
EU219982 Hymenoscyphus sp. *
AY348585 H. lasiopodius
100
AY348586 H. lasiopodius
AY348587 H. lasiopodius
DQ431167 H. tamaricis
95
84
AY348581 H. epiphyllus
98
AY348580 H. epiphyllus
DQ431180 H. epiphyllus
DQ491485 Lachnum virgineum
0.05

Fig. 1. Neighbor-joining tree of *Hymenoscyphus* species based on the ITS rDNA. Numbers above the branches are the bootstrap values (1000 replication, values smaller than 50% not shown). The numbers of nucleotide changed among taxa are represented by branch length and scale bar equals the number of nucleotide substitution per site. Taxa sequenced from this study marked with asterisk (*). *Lachnum virgineum* was chosen as outgroup.

such as leaves of grasses, oaks and other broad-leaved trees. This indicates that this species has a substrate-specific property on ginkgo leaves.

At first glance, the macroscopic features such as its long-stipitate apothecia and the discoloration of dried disc are reminiscent of *H. serotinus* (Pers.) W. Phillips. The measurements also agree with the descriptions of *H. serotinus* for most structures. However, pigmentation of the paraphyses in dried materials separates them: the pigment in *H. serotinus* is yellow to light brown (Dumont & Carpenter 1982), while that in *H.* sp. is deep violet. *Hymenoscyphus serotinus* was reported as associated with woody substrates, mainly of *Fagus sylvatica* in Europe (Lizoň 1992) and on herbaceous stems and leaves in South America (Dumont & Carpenter 1982). Zhuang (1996) reported this fungus (as *Lanzia serotinus*) on leaf blades of *Ulmus* sp. in China, but there have been no additional records of *H. serotinus* growing on leaves of woody plants, including ginkgo tree. *Hymenoscyphus caudatus* (P. Karst.) Dennis, reported on various leaves, is also similar to the present fungus but is distinguished by its shorter stipe (≤ 2 mm long).

The morphological discrepancy is supported by high genetic distances from other species of *Hymenoscyphus*. In the neighbor-joining tree, sequence data of the *Hymenoscyphus* sp. (EU096525 and EU219982) were independently nested within the genus *Hymenoscyphus* (Fig. 1). The next closest clade, consisting of *H. immutabilis* (Fuckel) Dennis, *H. globus* W.Y. Zhuang & Yan H. Zhang, and *H. crataegi* Baral & R. Galan, grouped with *Hymenoscyphus* sp. with moderate bootstrap value of 65% but shared significant sequence dissimilarities with the latter fungus (9.4–9.9%). They also differed morphologically spore shape, ectal excipular structure, and ecological habitat. In contrast *H. serotinus* and *H. caudatus* were distinctly separated from *Hymenoscyphus* sp. despite their morphological similarity. Baral et al. (2006) already noted such discordance between morphological and molecular data of some *Hymenoscyphus* species. Based on morphological features and molecular evidence, we describe and illustrate the fungus as a new species, *H. ginkgonis*.

Hymenoscyphus ginkgonis J.G. Han & H.D. Shin, **sp. nov.** **Fig. 2**

MycoBank MB511133

Apothecia superficialia, longe stipitata. Disco 0.5–2.0 mm diametro, plana vel anguste concava, albido ab pallide sufflavo, sicco fusco-brunnea. Receptaculo glabro, constans albido ab sufflavo. Stipes tenuis, usque 7 mm longus. Excipulum ectale ex textura prismatica compositur, cellulis hyalinis tenuiter tunicatis, 15–29 x 6–11 μm. Excipulum mudulosum textura porrecta vel intricata compositum, hyphis 2–3 μm latis. Asci cylindraceo-clavati, octospori, poro iodo caerulescentia, 72–98 x 8–11 μm. Ascosporae irregulariter biseriatae, elliptico-clavatae, hyalinae, rectae vel minute curvatae, unicellulares vel 1-septatae, 17–22 x 3–4 μm. Paraphyses cylindraceae, sicco fusco-violaceae, septatae, apicibus anguste clavatis, usque ad 2 μm latis.

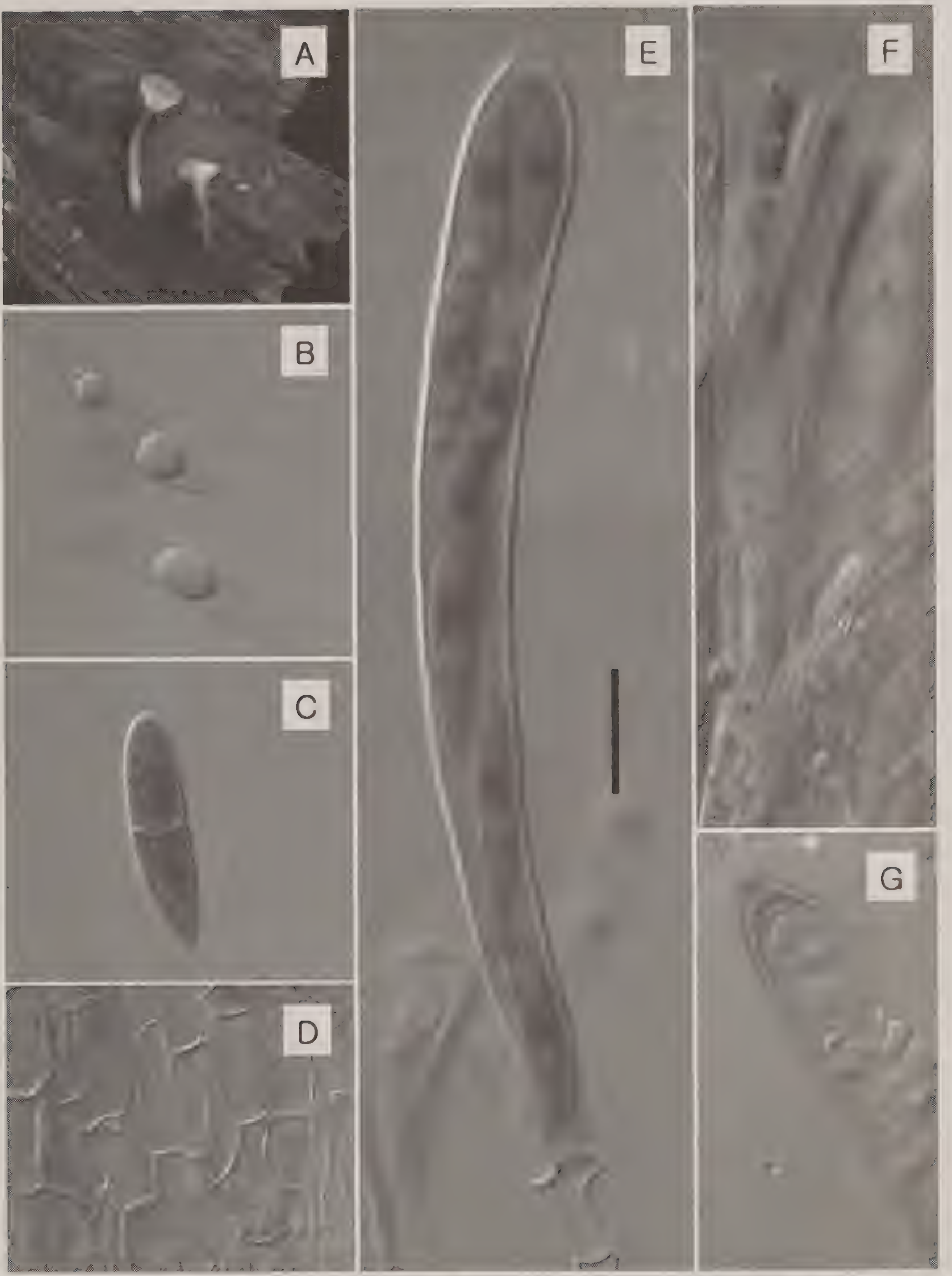

Fig. 2. *Hymenoscyphus ginkgonis* (KUS-F51352). A: apothecia occurring on a fallen leaf of *Ginkgo biloba*, B: ascospores containing guttules, C: 1-septate ascospore, D: ectal excipulum composed of prismatic cells, E: ascus arising from simple septum, F: apex of paraphyses turning deep violet in dried materials, G: apical pore blued in Melzer's reagent.

Scale bar: 4 mm for A, 10 µm for B, C, E, F and G, 20 µm for D.

Holotype — Korea, Wonju, Mons Chiak, alt. 430m, 37°23'56" N, 128°2'57" E, ad folia *Ginkgo biloba*, 15 September 2006, leg. J.G. Han & H.D. Shin (KUS-F51352).

Etymology — "*ginkgonis*" refers to the host plant on which the fungus was collected.

Apothecia superficial, disc-shaped and long-stipitate. Disc 0.5–2.0 mm in diameter, flat to slightly concave, white to pale yellowish when fresh, turning dark brown when dry. Receptacle smooth, concolorous with the hymenium when fresh, but, no discoloration occurred when dry. Stipe up to 7 mm long, slender, white. Ectal excipulum composed of thin-walled, hyaline, prismatic cells 15–29 x 6–11 µm in the flanks of the cup, becoming textura porrecta at the stipe, hyphae 2–3 µm wide. Medullary excipulum composed of textura porrecta to textura intricata. Asci arising from simple septa, cylindric-clavate, hyaline, 8-spored, apex conical, apical pore blued in Melzer's reagent, 72–98 x 8–11µm. Ascospores irregularly biseriate, elliptic-clavate, pointed at one end, straight to slightly curved, hyaline, smooth, containing several guttules, 0–1-spetate, 17–22 x 3–4 µm. Paraphyses cylindric, slightly swelling upward or not, up to 2 µm wide at the apex, apex turning deep violet in dried material, septate, equal to or only slightly exceeding the asci.

Specimens examined: Korea, Wonju, Mt. Chiak National Park, alt. 430m, 37°23'56" N, 128°2'57" E, on fallen leaves of *Ginkgo biloba*, 15 September 2006, leg. J.G. Han & H.D. Shin (Holotype: KUS-F51352); same locality, 30 August 2007 (KUS-F51817); Korea, Yangpyeong, Experimental Forest of Korea University, alt. 240m, N37°24'49.25" E127°43'5.32", on fallen leaves of *G. biloba*, 10 September 2007, leg. H.D. Shin (KUS-F51854).

Acknowledgments

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Literature cited

Aoki T. 1997. Fungal association with *Ginkgo biloba*. In: Hori T, Ridge W, Tulecke W, Del Tredici P, Tremouillaux-Guiller J, Tobe H. Eds. *Ginkgo biloba*: a global treasure from biology to medicine. Springer-Verlag: Tokyo, Japan. pp. 251-257

Baral H-O, Galán R, López J, Arenal F, Villarreal M, Rubio V, Collado J, Platas G, Peláez F. 2006. *Hymenoscyphus crataegi* (*Helotiales*), a new species from Spain and its phylogenetic position within the genus *Hymenoscyphus*. Sydowia 58(2): 145-162.

Dumont KP, Carpenter SE. 1982. Los hongos de Colombia - VII: *Leotiaceae* - IV: *Hymenoscyphus caudatus* and related species from Colombia and adjacent regions. Caldasia 13: 567-602.

Fontana A. 1985. Vesicular-arbuscular mycorrhizas of *Ginkgo biloba* L. in natural and controlled condition. New Phytol. 99: 441-447.

Lee S, Taylor JW. 1990. Isolation of DNA from fungal mycelia and single spores. In: Innis MA, Gelfand DH., Shinsky JJ, White TJ. Eds. PCR protocols: A Guide to Methods and Applications. Academic Press. San Diego, California. pp. 282-287.

Lizoň P. 1992. The genus *Hymenoscyphus* (*Helotiales*) in Slovakia, Czechoslovakia. Mycotaxon 45: 1-59.

Saitou N, Nei M. 1987. The neighbor-joining method: a new method for reconstructing phylogenetic trees. Mol. Biol. Evol. 4: 206-425.

Swofford DL. 2002. PAUP*. Phylogenetic analysis using parsimony (*and other methods), version 4b10. Sunderland, Massachusetts: Sinauer.

Vasilyeva LN, Mel'nik VA. 2006. New pyrenomycetous species from Korea and South Africa. Mikol. Fitopatol. 40: 89-92.

White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetic. In: Innis MA, Gelfand DH, Shinsky JJ, White TJ. Eds. PCR protocols: a Guide to Methods and Applications. Academic Press: San Diego, California. pp. 315-322.

Zhuang WY. 1996. The genera *Lambertella* and *Lanzia* (*Sclerotiniaceae*) in China. Mycosystema 8-9: 15-38.

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Additions to the knowledge of lignocellulolytic basidiomycetes in forests from Santa Catarina, Southern Brazil

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Abstract — An updated checklist of the lignocellulolytic basidiomycetes in Santa Catarina State with 110 species distributed in 19 families and six orders (*Agaricales, Hymenochaetales, Polyporales, Russulales, Auriculariales, Tremellales*) is presented. The complete checklist is available on http://www.mycotaxon.com/resources/weblists.html and as Electronic Guide BASC (Basidiomycetes of Santa Catarina) as well on http://www.cienciasbiologicas.ufsc.br/bot/micologia/index.htm.

Introduction

Basidiomycota comprises almost 30,000 species with *Basidiomycetes* representing approximately 70% (more of the 20,000 spp.) of the phylum (Kirk et al. 2001, David 2002). The basidiomycetes include wood decomposing organisms in most ecosystems causing white and brown rots in tropical areas where they are very abundant (Nobles 1971, Dix & Webster 1995, Deacon 1997, Anagnost 1998, Highley & Dashek 1998, Bononi & Grandi 1999). In Southern Brazil, the Santa Catarina State (26°–30° S lat, 48°30'–54° W long) presents two major vegetation types: the Atlantic Rain Forest and the Atlantic Semi-deciduous Forest (Morellato & Haddad 2000). In these ecosystems, Polypore fungi were first studied by Europeans Mycologists already in the 19th century (Loguercio-Leite 1990). The contributions by Brazilian researches from the Mycology Laboratory (BOT/CCB/UFSC) in Santa Catarina State has been taking place since 1990, with several works based on collections from the Atlantic Forest (Loguercio-Leite & Wright 1991ab, Loguercio-Leite 1992, 1993, 1994; Loguercio-Leite & Wright 1995, Gerber 1996, Gerber & Loguercio-Leite 1997, Loguercio-Leite & Gerber 1997, Loguercio-Leite & Wright 1998, Loguercio-Leite et al. 1998, Gerber et al. 1999, Neves & Loguercio-Leite 1999, Gerber & Loguercio-Leite 2000, Gonçalves 2001, Loguercio-Leite et al. 2001, 2002; Groposo & Loguercio-

Leite 2005). The purpose of this study was to estimate the species diversity of basidiomycetes in Santa Catarina State.

Material and methods

This study is based on the collections deposited in the herbarium FLOR since 1983 (Holmgren et al. 1990). Basidiomes were studied using macroscopic (shape, size, colors, types of hymenophore) and microscopic (presence/absence of structures, dimensions, basidiospores) characters (Ryvarden 1991). Measurements were made from slide preparations stained with 1% aqueous phloxine and 5% KOH. Melzer's reagent was used to define wall chemical characteristics. Specimens were identified to species using specialized references and comparing collections with BAFC, ICN and PACA Herbaria collections. Nomenclature, taxonomy and author citation followed Kirk et al. 2001 and databases: Centraalbureau voor Schimmelcultures – CBS (http://www.cbs.knaw.nl/databases/) and Index Fungorum – IFS (http://www.indexfungorum.org/Names/Names.asp). For geographic references consult the map of Santa Catarina State in Groposo & Loguercio-Leite (2005).

Results and discussion

As a contribution to the general checklist of the lignocellulolytic fungi (*Basidiomycetes*) in Santa Catarina State a total of 110 species is presented. The taxa are distributed in 19 families and six orders. *Polyporales* is the most representative order with 74 species in 12 families, followed by *Hymenochaetales* with 25 species in two families. The high diversity of *Polyporales* found in the present study agrees with the results of other inventories of the basidiomycetes on subtropical Southern Brazil (Groposo & Loguercio-Leite 2005) and also in tropical Northeastern Brazil (Gibertoni et al. 2004). Consequently, *Polyporaceae* is the most representative family with 45 species, followed by *Hymenochaetaceae* with 23 species. *Phellinus* s. l. is the genus with the highest number of species with 16 taxa. Most of the reported species showed a tropical distribution: 47 neotropical (almost 42.7%) and 42 pantropical species (38.2%). Only 8 and 13 species are considered widely distributed (7.3%) and cosmopolitan (11.8%), respectively. Up to now, these 110 species added here to the original list of lignocellulolytic fungi (Groposo & Loguercio-Leite 2005) increases to 157 species the total diversity of these organisms in Santa Catarina State, Brazil. The results revealed a high mycodiversity in Santa Catarina State, which corresponds to the knowledge of the basidiomycetes in the Atlantic Forest of Southern Brazil. From the total 157 species, 75.8% (119 species) are tropical (pantropical and neotropical). Besides the 4 species known only from Brazil [*Amauroderma corneri* Gulaid & Ryvarden, *Antrodiella multipileata* C.L. Leite & J.E. Wright, *Henningsia brasiliensis* (Speg.) Speg., *Skeletocutis roseolus* (Rick ex Theiss.) Rajchenb.] cited earlier by Groposo & Loguercio-Leite (2005), we report ten additional species endemic to this country: *Phellinus bambusarum* (Rick) M.J. Larsen, *Ceriporiopsis cystidiata* C.L. Leite et al., *Rigidoporus amazonicus* Ryvarden, *Diplomitoporus dilutabilis* C.L. Leite & J.E. Wright, *Rubroporus carneoporis* C.L. Leite et al., *Tyromyces crassisporus* C.L. Leite & J.E. Wright, *Tyromyces hypocitrinus* (Berk.) Ryvarden, *Wrightoporia porilacerata* C.L. Leite et al., *Pyrofomes fulvoumbrinus* (Bres.) A. David & Rajchenb., and *Protomerulius substuppeus* (Berk. & Cooke) Ryvarden. Of these, six are known only to Santa Catarina State. Only eight of the 157 taxa cause brown rot [*Fistulina hepatica* (Schaeff.) With., *Fomitopsis feei* (Fr.) Kreisel, *Gloeophyllum striatum* (Sw.) Murrill, *Antrodia albida* (Fr.) Donk, *Laetiporus sulphureus* (Bull.) Murrill, *Amylosporus bracei* (Murrill) A. David & Rajchenb., *Wrightoporia avellanea* (Bres.) Pouzar, and *Wrightoporia porilacerata*]. Consequently, 93-95% of the lignocellulolytic fungi from Santa Catarina caused white rots, confirming the trends given for tropical and subtropical areas by several authors (Nobles 1971, Gilbertson 1980, Nakasone 1996).

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Literature cited

Anagnost SE. 1998. Light Microscopic Diagnosis of Wood Decay. IAWA Journal 19(2): 141-167.

Bononi VLR, Grandi RAP. 1999. Zigomicetos, Basidiomicetos e Deuteromicetos. São Paulo: Instituto Botânica.

David JC. 2002. A Preliminary Catalogue of the Names of Fungi above the Rank of Order. Constancea 83.

Deacon JW. 1997. Modern Mycology. United Kingdom, Blackwell Science, 3rd edition.

Dix NJ, Webster J. 1995. Fungal Ecology. Ed. Chapman & Hall, First edition: 161-163.

Gerber AL. 1996. Fungos Xilófilos poróides (*Aphyllophorales*) on the Lagoa da Conceição, Ilha de Santa Catarina, SC, Brasil. Insula 25: 3 – 68.

Gerber AL, Loguercio-Leite C. 1997. New records of polypores (*Aphyllophorales*) from southern Brazil. Mycotaxon 62: 305-318.

Gerber AL, Loguercio-Leite C. 2000. Polyporoid wood-rotting fungi (*Basidiomycetes*) II – New records from southern Brazil. Mycotaxon 76: 175-185.

Gerber AL, Neves MA, Loguercio-Leite C. 1999. Some species of *Perenniporia* Murrill (*Poriales, Basidiomycotina*) from Southern Brazil. Revista Brasileira de Botânica 22(2): 185-193.

Gibertoni TB, Ryvarden L, Cavalcanti MAQ. 2004. Studies in neotropical polypores 18 New species from Brazil. Synopsis Fungorum 18: 44-56.

Gilbertson RL. 1980. Wood-rotting fungi of North América. Mycologia 72(1): 1-49.

Gonçalves GVC, Loguercio-Leite C. 2001. Biodiversidade de Fungos Poróides Xilófilos (Basidiomycetes), na Unidade de Conservação Ambiental Desterro (UCAD), Ilha de Santa Catarina, SC, Brasil. Insula 30: 1-19.

Groposo C, Loguercio-leite C. 2005. Contribution to the lignocellulolytic fungi (*Basidiomycetes*) of the Atlantic Rain Forest in Southern Brazil. Mycotaxon 92: 103-106.

Highley TL, Dashek WV. 1998. Biotechnology in the Study of Brown- and White-rot Decay. Forest products Biotechnology: 15-35.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum: Part I: Herbaria of the World. 86ª ed. Bronx, New York Botanical Garden.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9° Ed, CAB International.

Loguercio-Leite C. 1990. Revisão histórica sobre fungos poliporóides (*Aphyllophorales*) xilófilos de Santa Catarina. Insula 20: 3-10.

Loguercio-Leite C. 1992. El género *Polyporus* (*Polyporaceae*) en la Isla de Santa Catarina, Santa Catarina, Brasil. Boletín de la Sociedad Argentina 28(1-4): p. 27-36.

Loguercio-Leite C. 1993. *Polyporaceae* II: *Trametes* Fr. Na Ilha de Santa Catarina, SC, Brasil. Insula 22: 3-20.

Loguercio-Leite C. 1994. *Polyporaceae* na Ilha de Santa Catarina III: o gênero *Hexagonia* Fr. Insula 23: 3-14.

Loguercio-Leite C, Gerber AL. 1997. Non-pileate polypores on Santa Catarina Island, SC, Brazil. Mycotaxon 64: 285-301.

Loguercio-Leite C, Gerber AL, Ryvarden L.1998. *Wrigthoporia porilacerata*, a new species of pore fungi from southern Brazil. Mycotaxon 67: 251-255.

Loguercio-Leite C, Gonçalves GV, Ryvarden L. 2001. Studies in Neotropical polypores 13. *Ceriporiopsis cystidiata* sp. nov. Mycotaxon 79: 285-288.

Loguercio-Leite C, Ryvarden L, Groposo C. 2002. Studies in neotropical polypores 16. *Rubroporus carneoporis* genus & species nova. Mycotaxon 83: 223-227.

Loguercio-Leite C, Wright JE. 1991a. Contribution to a biogeographical study of the austroamerican xilophilous polypores (*Aphyllophorales*) from Santa Catarina Island, SC, Brazil. Mycotaxon 41(1): 161-166.

Loguercio-Leite C, Wright JE. 1991b. New South American Pileate Polypores (*Polyporaceae*) from Santa Catarina Island, SC, Brazil. Mycotaxon 41(1): 167-172.

Loguercio-Leite C, Wright JE. 1995. The Genus *Phellinus* (*Hymenochaetaceae*) on the Island of Santa Catarina, Brazil. Mycotaxon 54: 361-388.

Loguercio-Leite C, Wright JE. 1998. *Diplomitoporus dilutabilis* a new species of *Polyporaceae* (*Aphyllophorales*) from Santa Catarina Island, Brazil. Mycotaxon 68: 47-51.

Morellato LPC, Haddad CFB. 2000. Introduction: the Brazilian Atlantic Forest. Biotropica 32(4b): 786-792.

Nakasone KK. 1996. Diversity of lignicolous *Basidiomycetes*. In: Mcmiinn JW, Crossley DA. Biodiversity and Coarse Windy Debris in Southern Forests, Proceedings of the Workshop on coarse woody debris in Southerns forests: effects on Biodiversity. Departament of Agriculture, Forest Service, Southern Research Satation, Athens. 146p.

Neves MA, Loguercio-Leite C. 1999. Cultural characteristics and taxonomy of some polypores (*Aphyllophorales*) from Santa Catarina Island, SC, Brazil. Mycotaxon 70: 193-202.

Nobles MK. 1971. Cultural characters as a guide to the taxonomy of the *Polyporaceae*. In: Petersen R. Evolution in the higher *Basidiomycetes*. University of Tennessee Press, Knoxville: 169-196.

Ryvarden L. 1991. Genera of Polypores. Nomenclature and taxonomy. Synopsis Fungorum 5. Oslo, Fungiflora, 226p.

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Bulbothrix viatica, a new species of *Parmeliaceae* from Brazil

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Abstract– *Bulbothrix viatica* is here proposed as new. It is a very common species that has been confused with *Bulbothrix subcoronata* but differs in its brown undersurface, larger ascospores, and wider lobes.

Key words– lichens, bulbate cilia, Rio Grande do Sul

The lichen genus *Bulbothrix* Hale (*Parmeliaceae*) is diagnosed by the bulbate marginal cilia, pale grey upper cortex, and production of atranorin (Hale 1974, 1976). *Relicina* (Hale & Kurok.) Hale also has bulbate cilia, but the cortex is yellowish colored, with usnic acid (Hale 1975, Elix 1996).

At present 48 species of *Bulbothrix* are known (Farr et al. 1999), 20 of which have been recorded from Brazil (Marcelli 2005) and six from the state Rio Grande do Sul (Spielmann 2006). Furthermore, six new species recently discovered in south and southeastern Brazil are in the process of publication (Canêz & Marcelli 2007, Jungbluth et al. 2008). This supports Hale's (1976) earlier assertion that Brazil is the center of diversity for the genus.

During our *Parmeliaceae* research along the roadsides and slopes in the central region of the Rio Grande do Sul State (Spielmann 2005), we found an interesting species of *Bulbothrix* that is described for the first time below.

Bulbothrix viatica A.A. Spielm. & Marcelli, **sp. nov.** Fig. 1
MycoBank MB 511147

Thallus adnatus, cinereo-glaucescens, membranaceus, margine bulbato-ciliatus, isidiis sorediisque destitutus, subtus brunneus, rhizinosus, rhizinis nigris vel atrobrunnescentibus, simplicibus. Apothecia coronata, sporae 12.0–16.5 × 7.5–10.0 μm, episporio 1–2 μm crasso. Thallus K+ flavescens, medulla K+ primo lutescens, dein valde aurantiaca; atranorinam et acidum norsticticum continens.

Holotypus– Brazil, Rio Grande do Sul State, Municipio Santa Cruz do Sul, margin of the highway RST-287, km 102, 29°41'03.3"S, 52°25'33.6"W, 150 m alt., roadside, on *Eucalyptus* branch, 28 July 2003, A.A. Spielmann 389 (SP)

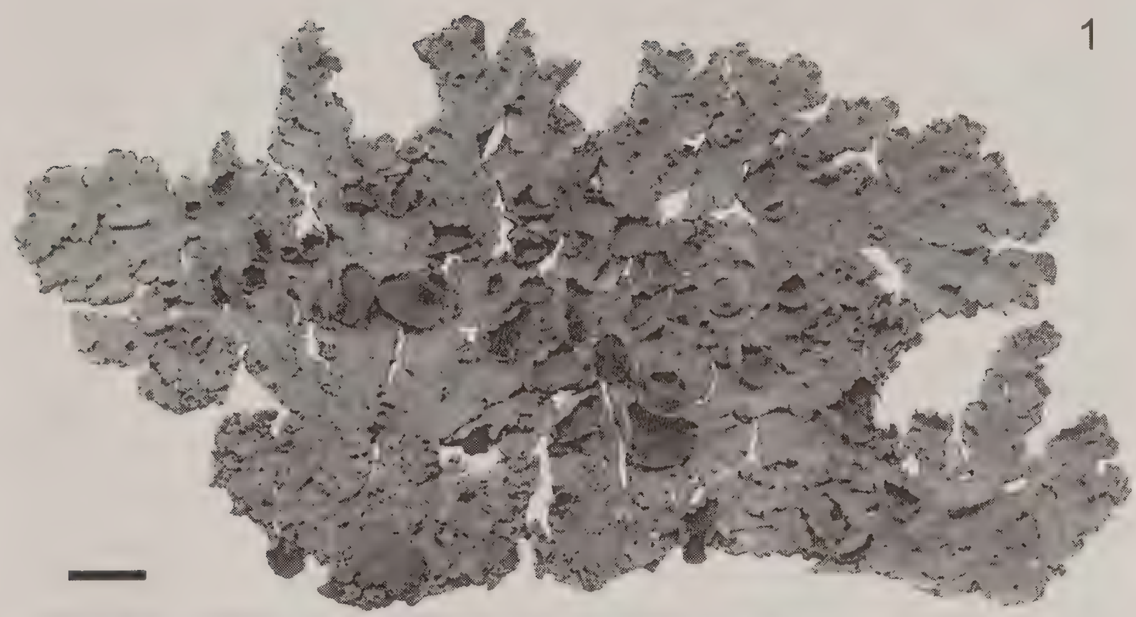
Thallus greenish gray, lobate, adnate, membranaceous, saxicolous or corticolous, 1.5–7.5 cm in diameter; lobes (sublaciniae) irregularly branched, laterally overlapping, 1–4 mm wide, with rounded tips, margins crenate to crenate-incised (sublacinulate); distal surface smooth to slightly rugose, becoming rugose and cracked toward the center; lacinulae absent; maculae absent; cilia black, bulbate, simple, frequent, located at the lobe and crenae axils, with one or rarely two apices per bulb, 0.05–0.70 × 0.02–0.15 mm (including bulb). Pustulae absent. Soredia absent. Isidia absent. Medulla white or sometimes with some K– light orange points. Lower surface brown to dark-brown, dull, smooth to rugose; margin dark-brown, 1.0–1.5 mm wide, bare, with attenuate transition to the central parts, smooth to rugose or sometimes veined at the edge; rhizines black to dark brown, simple, base not or just slightly bulbate, 0.10–0.50 × 0.01–0.04 mm, abundant, evenly dispersed. Apothecia urceolate to concave, 1.5–8.0 mm in diameter, sessile to substipitate, laminal, margin crenate, coronate, coronal bulbs sometimes with ciliate apices, amphithecium smooth, sometimes with scarce bulbs, disc brown, matt, epruinose, imperforate; epithecium 2.5–12.0 μm thick; hymenium 55–75 μm tall; subhymenium 12.5–25.0 μm thick; ascospores ellipsoid to narrowly ellipsoid, 12.0–17.5 × 7.5–10.0 μm, episporium 1.0–2.0 μm thick. Pycnidia submarginal to laminal, conspicuous, with or without a prominent margin, ostiole black; conidia bifusiform (sometimes hardly distinct), 5.0–7.5 × ca. 1.0 μm.

Chemistry: cortex K+ yellow, UV–; medulla K+ yellow → strongly orange or orange-red, C–, KC–, P+ orange-yellow, UV–; containing atranorin (cortex), norstictic acid and connorstictic acid (medulla).

Paratypes: Brazil, Rio Grande do Sul State. Herveiras Municipality, 29°27'12.5"S, 52°37'57.7"W, 540 m alt., on a roadside *Eucalyptus* trunk, open place, *A.A. Spielmann, L.S. Canêz & C. Trentin* 714, 24 January 2004. Idem, Santa Cruz do Sul Municipality, margin of highway RST-287, Km 102, 29°41'03.3"S, 52°25'33.6"W, 150 m alt., roadside, on an *Eucalyptus* branch, *A.A. Spielmann* 389, 28 July 2003. Idem, Sinimbu Municipality, Cava Funda, 29°27'41.8"S, 52°31'11.7"W, 500 m alt., corticolous, on roadside, open place, *A.A. Spielmann* 1318, 12 February 2003; idem, 29°27'33.4"S, 52°31'05.1"W, 520 m alt., saxicolous, on roadside, open place, *A.A. Spielmann* & *L.S. Canêz* 713, 05 May 2004; idem, ca. 1 Km from Linha Almeida, 29°23'20.2"S, 52°30'21.9"W, on fallen branch at roadside, open place, *A.A. Spielmann* & *L.S. Canêz* 1336, 05 January 2004. Idem, Sobradinho Municipality, margin of highway RST-481, next to the crossroads, 29°24'20.2"S, 53°01'25.9"W, 375 m alt., corticolous, on bush at roadside, open place, *A.A. Spielmann* 341, 17 July 2003.

Comments–The absence of vegetative propagules, coronate apothecia, a brown to dark-brown undersurface, a medulla with norstictic acid (K+ yellow →

1



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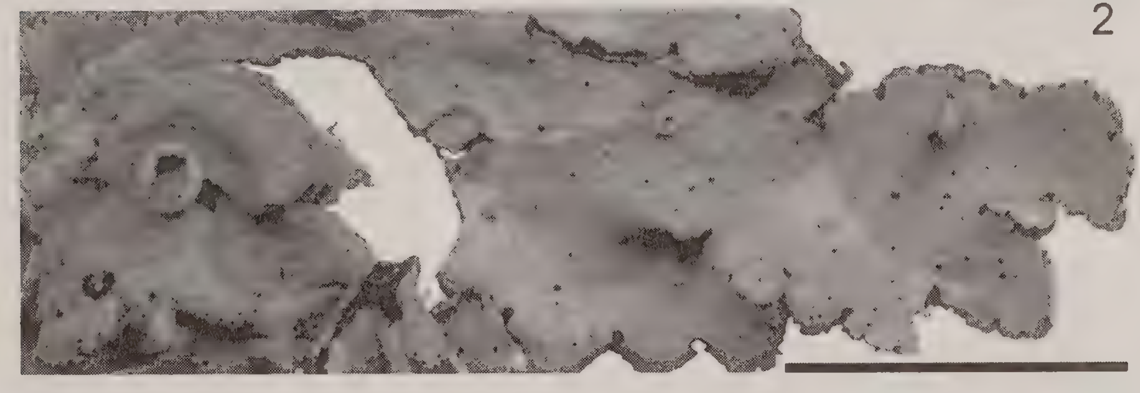

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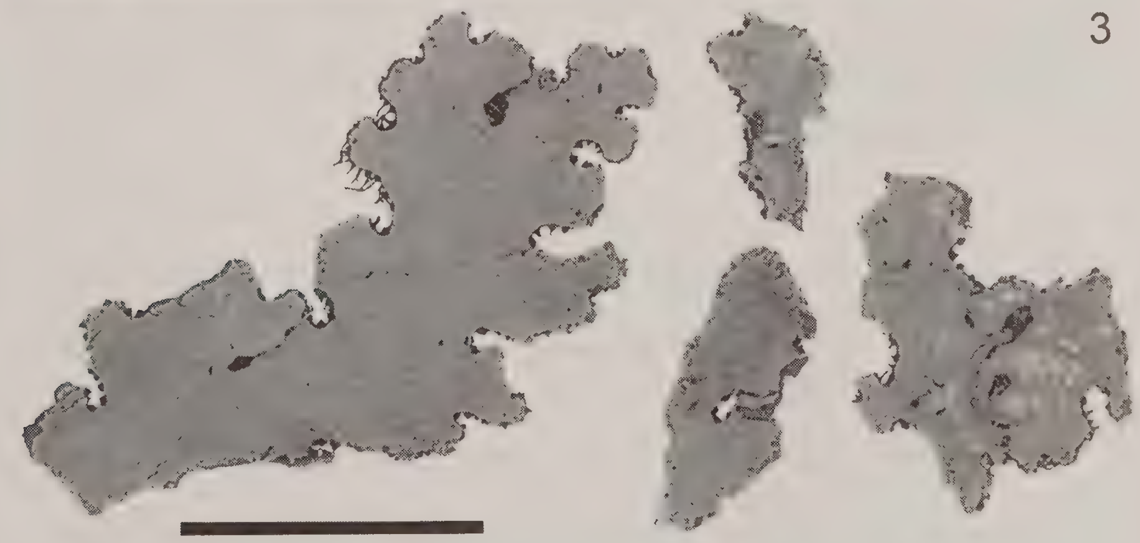

Fig. 1. *Bulbothrix viatica* (holotype).
Fig. 2. *Bulbothrix viatica* (detail of holotype).
Fig. 3. *Bulbothrix subcoronata* (the complete holotype).
Bars = 5 mm.

intense orange or orange-red), large (12.0–17.5 × 7.5–10.0 µm) ascospores and wide (1–4 mm) lobes differentiate *Bulbothrix viatica* from related species.

The studied specimens were at first identified as *Bulbothrix subcoronata* (Müll. Arg.) Hale, since all available keys and descriptions attribute this name to any *Bulbothrix* material having a brown undersurface, large (7–20 × 5–10 µm) ascospores, and lobes 0.5–3.0 mm wide (Hale 1976, Fleig 1985, Marcelli 1993, Ribeiro 1998, Eliasaro 2001).

However, *B. subcoronata* was originally described [*Parmelia subcoronata*] as having small (ca. 5 µm long), broadly ellipsoid to subglobose ascospores (Müller 1887). Analysis of the holotype (G!, Fig. 2) shows that it has a shiny black underside and lobes just 0.5–1.0 mm wide. Furthermore, the ascospores were found to measure actually 5.0–7.5 × 4.0–5.5 µm, with an episporium ca. 0.5 µm (Benatti, pers. comm.).

Therefore, it is highly possible that the specimens cited in the literature listed above as *Bulbothrix subcoronata* belong, in fact, to *B. viatica*.

This species is relatively common along roadsides in the studied area; therefore the specific epithet *viatica* (= growing along roads, fide Stearn 1992) was chosen.

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Literature cited

Canêz LS, Marcelli MP. 2007. Novelties in Southern Brazilian *Parmeliaceae.* Mycotaxon. In prep.

Eliasaro S. 2001. Estudio taxonómico y floristico sobre las *Parmeliaceae* sensu stricto (*Ascomycota* Liquenizados) del Segundo Planalto del Estado de Paraná, Brasil. Buenos Aires. Tesis de Doctor (en Ciencias Biológicas). Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales. 267 p.

Elix JA. 1996. A revision of the lichen genus *Relicina.* Bibliotheca Lichenologica 62: 1-150. 80 fig. 5 pl.

Farr ER, Hale BW, DePriest PT. 1999. *Parmeliaceae:* Searchable List of Names in the Parmelioid Genera (Lichens). <http://persoon.si.edu/parmeliaceae/> (Accessed in March 2006).

Fleig M. 1985. Estudo preliminar da família *Parmeliaceae* (Liquens) no Rio Grande do Sul, Brasil. Comunicações do Museu de Ciências da PUC/RS, série Botânica 35: 79-91.

Hale ME. 1974. *Bulbothrix, Parmelina, Relicina, and Xanthoparmelia,* four new genera in the *Parmeliaceae* (Lichenes). Phytologia 28 (5): 479-490.

Hale ME. 1975. A monograph of the lichen genus *Relicina* (*Parmeliaceae*). Smithsonian Contributions to Botany 26: 1-32.

Hale ME. 1976. A monograph of the lichen genus *Bulbothrix* Hale (*Parmeliaceae*). Smithsonian Contributions to Botany 32: 1-29.

Jungbluth P, Marcelli MP, Elix JA. 2007. Five new *Bulbothrix* from cerrado vegetation of São Paulo State, Brazil. Mycotaxon. In prep.

Marcelli MP. 1993. Pequenas *Parmelia* s. l. (Liquens: *Ascomycotina*) ciliadas dos cerrados brasileiros. Acta botanica brasilica 7: 25-70.

Marcelli MP. 2005. Checklist of lichens and lichenicolous fungi of Brazil. Version 1 September 2005. http://www.biologie.uni-hamburg.de/checklists/brazil_l.htm. Accessed in March 2006.

Müller "Argoviensis" J. 1887. Revisio Lichenum Féeanorum. Revue Mycologique 9 (35): 133-140.

Ribeiro CH. 1998. A família *Parmeliaceae* (*Ascomycota* liquenizados) em regiões montanhosas dos estados de Minas Gerais, Rio de Janeiro e São Paulo. Dissertação (mestrado em Botânica). Instituto de Biociências, Universidade de São Paulo. 194 p.

Spielmann AA. 2005. A família *Parmeliaceae* (fungos liquenizados) nos barrancos e peraus da encosta da Serra Geral, Vale do Rio Pardo, Rio Grande do Sul, Brasil. Dissertação (mestrado). Instituto de Botânica da Secretaria de Estado do Meio Ambiente. São Paulo. 204 p. Available at http://www.ibot.sp.gov.br/teses/teses.htm.

Spielmann AA. 2006. Checklist of lichens and lichenicolous fungi of Rio Grande do Sul (Brazil). Caderno de Pesquisa Série Biologia 18 (2): 7-125.

Stearn WT. 1992. Botanical Latin – History, Grammar, Syntax, Terminology and Vocabulary. 4th ed. Timber Press, Portland, Oregon. 546 p.

MYCOTAXON

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Taxonomic revision of the genus *Cladosporium* s. lat. 8. Reintroduction of *Graphiopsis* (= *Dichocladosporium*) with further reassessments of cladosporioid hyphomycetes

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Abstract — *Graphiopsis* is shown to be an older, valid name for the recently introduced genus *Dichocladosporium*. The new name *Cladosporium vincicola* is introduced and the new combinations *Fusicladium britannicum* (≡ *Cladosporium britannicum*) and *F. psammicola* (≡ *Exosporium psammicola*, *Cladosporium psammicola*) are proposed. The fungus represented by the invalid name *Cladosporium indigoferae* is described and illustrated. Due to insufficient material, however, its generic affinity could not be resolved.

Key words — anamorphs, cladosporium-like

Introduction

Based on a new phylogenetic and morphological circumscription of the heterogeneous genus *Cladosporium* Link (David 1997, Braun et al. 2003, Schubert et al. 2007b), attempts to redescribe and reassess the numerous species previously assigned to this genus (Dugan et al. 2004) have recently been made (Braun & Schubert 2007, Heuchert et al. 2005, Schubert 2005a,b; Schubert & Braun 2004, 2005a,b, 2007; Schubert et al. 2006, 2007a,b). In a recently published issue of 'Studies in Mycology' dedicated to cladosporioid fungi (Crous et al. 2007b), all aspects and kinds of hyphomycetes previously assigned to *Cladosporium* s. lat. (Crous et al. 2007a) have been addressed using standardized cultures and molecular approaches. This volume provides an important basis for the preparation of a projected monograph of *Cladosporium*.

In the present paper, the nomenclature of a recently introduced cladosporioid genus is discussed and some species, which are only known from type material and other herbarium specimens, are redescribed and reassessed.

Materials and methods

The collections examined were described, mounted in distilled water, using oil immersion (bright field and phase contrast), but without any staining, by means of standard light microscopy (Olympus BX 50, Hamburg, Germany). The collections examined are deposited at the herbaria BPI, CUP, HAL, IMI, LE, PAD, PPMH and W (abbreviations according to Holmgren et al. 1990).

Nomenclature and taxonomy

1. *Graphiopsis* – an older valid name for *Dichocladosporium*

Cladosporium chlorocephalum (≐ *C. paeoniae*) is a common, widespread hyphomycete of peony, characterized by dimorphic fruiting, and causing distinct necrotic leaf-blotch symptoms on living leaves, and with a second type of conidiophore and conidia on rotten, overwintered stems. Based on detailed re-examinations of this fungus in vivo and in vitro, supplemented by sequence data of the ITS and LSU gene regions, Schubert et al. (2007a) clearly demonstrated that this fungus has to be excluded from *Cladosporium* s. str. It is retained in the *Davidiellaceae* (*Capnodiales*), but forms a clade separate from the *Davidiella* Crous & U. Braun cluster. The placement of this fungus in a separate genus, '*Dichocladosporium*' was supported by its phylogenetic position and morphological peculiarities of the conidiophores, conidiogenous loci and hila. Unfortunately it was overlooked that *D. chlorocephala* (≡ *Periconia chlorocephala*), the type species of the former genus, is also the type species of an older, forgotten genus, *Graphiopsis*. Trail (1889) probably misinterpreted the name *P. chlorocephala* since he assigned Scottish collections on *Carex* spp., *Juncus effusus* and *Phragmites australis* to this species, which is confined to *Paeonia* spp. But peony was not listed under the hosts cited. This is, however, nomenclaturally irrelevant since Trail (1889: 76) clearly cited *Periconia chlorocephala* as type species of *Graphiopsis*. Hence, the following nomenclatural reassessment and correction is necessary:

Graphiopsis Trail, Scott. Naturalist (Perth) 10: 75. 1889
[non *Graphiopsis* Bainier 1907].
Type species: *G. chlorocephala* (Fresen.) Trail.
≡ *Dichocladosporium* K. Schub., U. Braun & Crous, Stud. Mycol. 58: 96. 2007.

Graphiopsis chlorocephala (Fresen.) Trail, Scott. Naturalist (Perth) 10: 76. 1889.
Neotype: On dead stems of *Paeonia officinalis*, Germany, Sachsen-Anhalt, Halle (Saale), Botanical garden, 16 Mar. 2005, K. Schubert (HAL 1924 F). Isoneotype: CBS-H 19869. Culture ex neotype: CBS 121523 = CPC 11969.

≡ *Periconia chlorocephala* Fresen., Beitr. Mykol. 1: 21. 1850.
≡ *Haplographium chlorocephalum* (Fresen.) Grove, Hardwicke's Sci.-Gossip 21: 198. 1885.
≡ *Cladosporium chlorocephalum* (Fresen.) E.W. Mason & M.B. Ellis, Mycol. Pap. 56: 123. 1953.
≡ *Dichocladosporium chlorocephalum* (Fresen.) K. Schub., U. Braun & Crous, Stud. Mycol. 58: 96. 2007.
= *Cladosporium paeoniae* Pass., in Thümen, Herb. Mycol. Oecon., Fasc. IX, No. 416. 1876, and in Bot. Jahresber. (Just) 4: 235. 1876.
= *Periconia ellipsospora* Penz. & Sacc., Atti Reale Ist. Veneto Sci. Lett. Arti, Ser. 6, 2: 596. 1884.
= *Cladosporium paeoniae* var. *paeoniae-anomalae* Sacc., Syll. Fung. 4: 362. 1886.
= *Haplographium chlorocephalum* var. *ovalisporum* Ferraris, Fl. Ital. Cryptog., Hyphales: 875. 1914.

2. ***Cladosporium vincicola*** U. Braun & K. Schub., **nom. nov.** FIG. 1
MYCOBANK, MB 511302
≡ *Cladosporium vincae* Moesz, Bot. Közlem. 23: 123. 1926, nom. illeg., non *C. vincae* Fairm., 1911.

MATERIAL EXAMINED: HUNGARY. Near Budapest, on living leaves of *Vinca herbacea* (*Apocynaceae*) infected by *Puccinia vincae* (DC.) Plowr., 25 Apr. 1926, W. Moesz (W 10216: lectotype, selected here). RUSSIA. St. Petersburg, Botanical Garden of the Komarov Botanical Institute, on living leaves of *Vinca minor*, 7 May 2007, V.A. Mel´nik (HAL 2069 F).

LEAF SPOTS usually initiated terminally or laterally, later spreading, covering large leaf segments, often more than 50 % of the leaf blade, finally entire leaves turning necrotic, shape and size of the lesions variable, dark brown to pale grayish brown, later dingy gray to grayish white, margin indefinite or with a narrow to moderately wide dark brown to blackish border or halo, sometimes with rather diffuse discolorations. CAESPITULI amphigenous, mainly hypophyllous, punctiform, scattered, dark brown. MYCELIUM internal, forming immersed stromatic aggregations, 10–80 μm diam., composed of swollen hyphal cells, pigmented, thick-walled, up to 12 μm diam. CONIDIOPHORES in small to moderately large fascicles, loose to moderately dense, occasionally solitary, arising from substomatal stromatic hyphal aggregations, emerging through stomata, erect, straight, subcylindrical to moderately geniculate-sinuous, rarely subnodulose, unbranched, 15–100 × 3–7.5 μm, at the very base sometimes up to 10 μm wide, 0–4(–6)-septate, pale to medium olivaceous or olivaceous-brown, wall 0.5–1 μm thick, one-layered, smooth to faintly rough-walled; conidiogenous cells integrated, terminal or intercalary, 10–35 μm long; conidiogenous loci distinctly coronate, somewhat protuberant, 1.5–2.5 μm wide and ca. 1 μm high. CONIDIA in simple or branched chains, ramoconidia lacking, secondary ramoconidia (sensu Schubert et al. 2007b) and conidia ellipsoid-ovoid, obovoid, fusiform, rarely subcylindrical, (4.5–)6–25(–33) × (3–)4–8(–9) μm, 0–3(–4)-septate, pale olivaceous to olivaceous-brown, wall thin, ca. 0.5 μm, sometimes distinctly two-layered and up to 1 μm thick, distinctly verruculose,

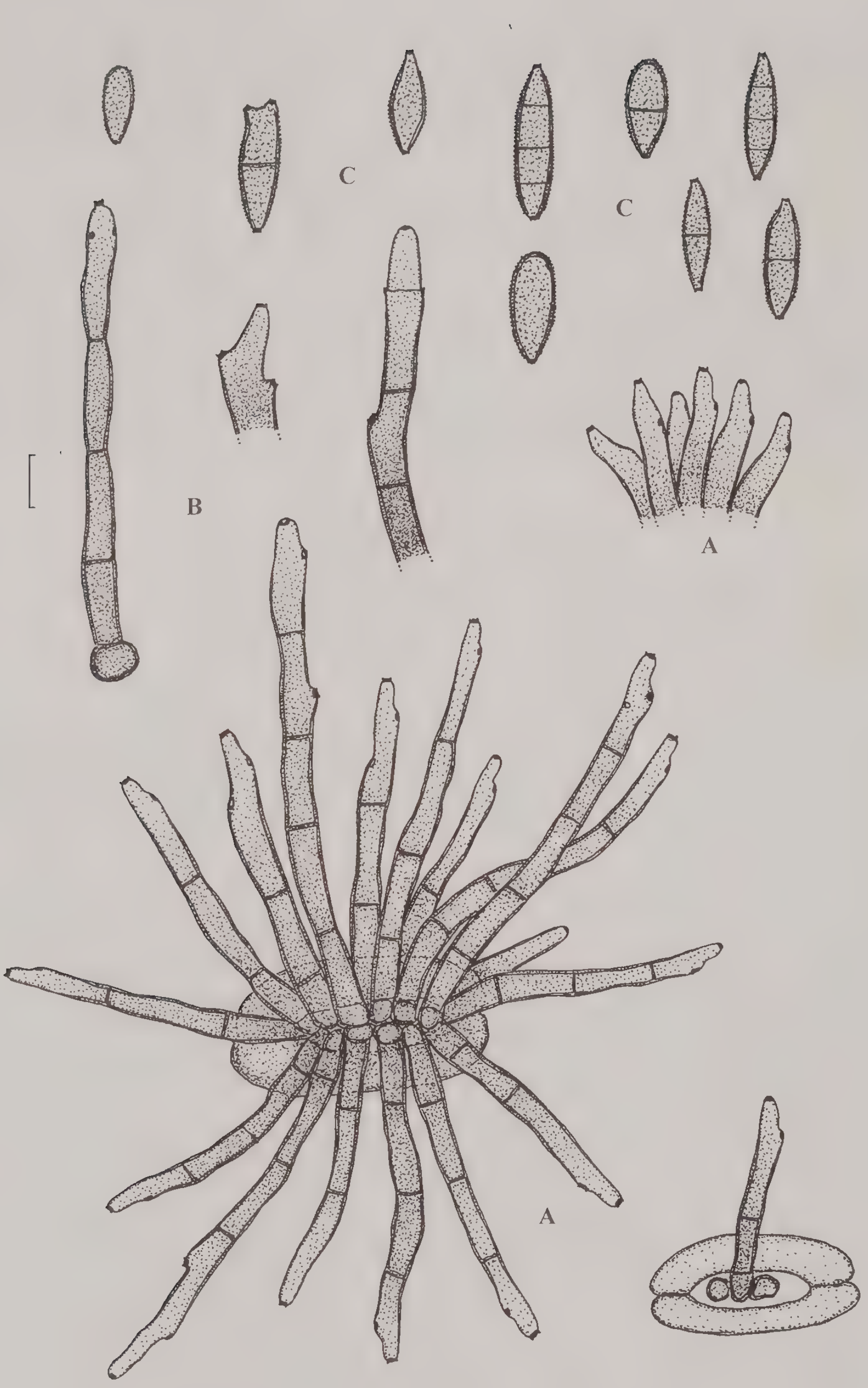

Fig. 1. *Cladosporium vincicola*.
A. Conidiophore fascicle. B. Conidiophores. C. Conidia.
Scale bar = 10 µm. U. Braun *del.*

apex rounded in conidia formed singly, attenuated in catenate conidia, base rounded, with an abruptly protuberant hilum or attenuated, 1–2 µm diam., occasionally with microcyclic conidiogenesis.

COMMENTS: Morphologically this species resembles *Cladosporium aecidiicola* Thüm. However, *C. vincicola* is undoubtedly biotrophic, forming distinct leaf lesions, with fasciculate conidiophores emerging through stomata, and is not associated with rust aecia. The fascicles of conidiophores arise from well-developed, large stromata. The conidia of *C. vincicola* agree well with those of *Cladosporium herbarum* (Pers.) Link s. str., but the conidiophores and the arrangement of the conidiogenous loci is different. The conidiophores in *C. vincicola* are non-nodulose, i.e., the conidiogenous loci are not confined to nodulose swellings as in *C. herbarum*. *Cladosporium vincae* Fairm. (material examined: on dead leaves of *Vinca minor*, USA, New York, Lyndonville, 6 May 1910, C.E. Fairman, CUP-F2873(24-68), holotype) is identical with *Cladosporium macrocarpum* Preuss, i.e., the conidiophores are distinctly nodulose with conidiogenous loci confined to swellings, and the conidia are rather broad, 5.5–11 µm, mostly 8–10 µm.

3. ***Fusicladium britannicum*** (M.B. Ellis) U. Braun & K. Schub., **comb. nov.** FIG. 2
MYCOBANK, MB 511303

≡ *Cladosporium britannicum* M.B. Ellis, More Dematiaceous Hyphomycetes: 328. 1976.

ILLUSTRATIONS: Ellis (1976: 327, Fig. 245 C), Ellis & Ellis (1985: Pl. 19, Fig. 190).

MATERIAL EXAMINED: UK. WALES, Pwee-y-Faeda Estate, on rotten wood of *Quercus* sp. (*Fagaceae*), 13 May 1973, collector unknown (IMI 175936: holotype).

COLONIES on rotten wood, effuse, dark to blackish brown, villose. MYCELIUM usually immersed; hyphae sparingly branched, 1–3 µm wide, septate, brown, with solitary or aggregated swollen hyphal cells, 3–10 µm diam., subglobose, brown, wall up to 1 µm thick, but genuine stromata lacking. CONIDIOPHORES solitary to loosely aggregated, arising from immersed hyphae or swollen hyphal cells, erect, straight, subcylindrical to flexuous, sinuous, rarely slightly geniculate, unbranched, 80–350 × 3–6(–8) µm, pluriseptate throughout, medium to dark brown, tip somewhat paler, wall slightly thickened, up to 1 µm wide, smooth; conidiogenous cells integrated, terminal, 10–30 µm long; conidiogenous loci inconspicuous to subconspicuous by being subdenticulate, apex truncate to somewhat convex, 1–2.5 µm diam., unthickened or almost so, but somewhat darkened-refractive. CONIDIA in simple or branched chains, (9–)12–20 × (4–)5–8 µm, primary conidia obovoid, apex rounded, base short obconically truncate, secondary conidia ellipsoid-ovoid, fusiform, both ends attenuated, tips (hila) truncate, pale brown to medium brown, wall thin, 0.5–1 µm wide, smooth, hila (1–)1.5–2.5(–3) µm diam., unthickened or almost so, but often somewhat darkened-refractive.

COMMENTS: Due to the non-coronate structure of the conidiogenous loci and conidial hila, this species has to be excluded from *Cladosporium* s. str. The subdenticulate, unthickened, but somewhat darkened-refractive loci and hila agree well with those of *Fusicladium* Bonord. (Schubert et al. 2003). Without cultures and molecular sequence analyses, it is rather difficult to distinguish *Fusicladium* anamorphs [*Venturiaceae*] from species of the genus *Cladophialophora* Borelli [*Herpotrichellaceae*] (Crous et al. 2007c). However,

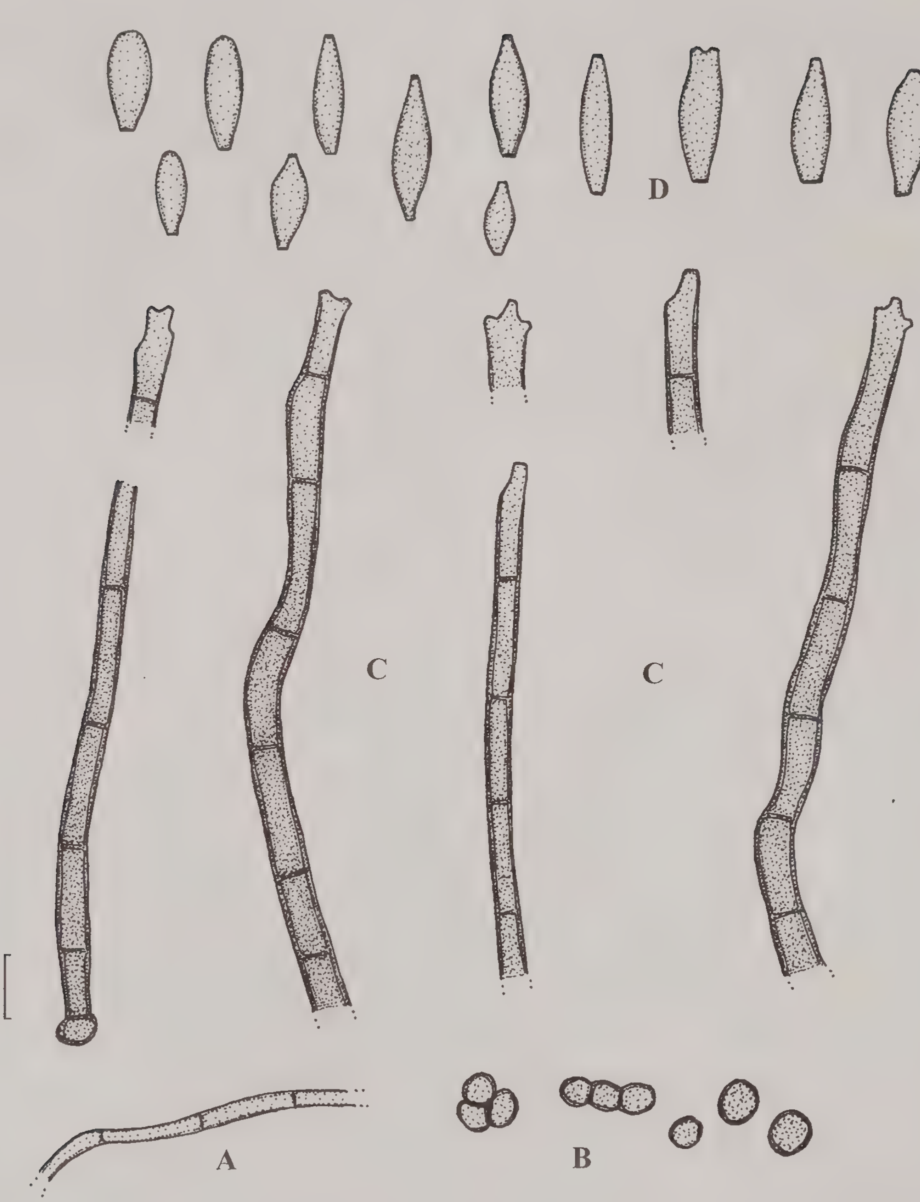

Fig. 2. *Fusicladium britannicum.*
A. Hyphae. **B.** Swollen hyphal cells. **C.** Conidiophores. **D.** Conidia.
Scale bar = 10 µm. U. Braun *del.*

based on the structure of the rather coarse, long and wide conidiophores, this species has been placed in *Fusicladium*.

4. ***Fusicladium psammicola*** (Sacc.) U. Braun & K. Schub., **comb. nov.** FIG. 3

MYCOBANK, MB 511304

≡ *Exosporium psammicola* Sacc., in Saccardo & Trotter, Ann. Mycol. 11: 420. 1913.

≡ *Cladosporium psammicola* (Sacc.) Morgan-Jones & W.B. Kendr., Canad. J. Bot. 50(9): 1817. 1972.

ILLUSTRATION: Morgan-Jones & Kendrick (1972: 1818, Fig. 1).

MATERIAL EXAMINED: LIBYA. Ras Carrac, Magna Syrte, on dead leaves of *Psamma arenaria* [≡ *Ammophila arenaria*] (*Poaceae*), 18 May 1913, A. Trotter (PAD: holotype).

Colonies on dead leaves, punctiform to subeffuse, dark brown to blackish, scattered to dense. Mycelium immersed, occasionally partly superficial, branched, septate, subhyaline to brown, 2–5 µm wide, forming irregularly radiating strands and aggregations of swollen hyphal cells, 3–9 µm wide, brown, wall somewhat thickened, septate, usually constricted at the septa, often confluent, forming irregular plates or stromata, up to 50 µm diam., immersed to erumpent. Conidiophores solitary, in loose groups or loose to dense fascicles, arising from hyphal aggregations or stromata, erect, subcylindrical-conical, unbranched, 5–35 × 3–6 µm (according to the original description up to 70 µm long), aseptate or septate, pale brown, wall thin to slightly thickened, smooth to faintly rough-walled; conidiogenous cells integrated, terminal or conidiophores reduced to conidiogenous cells, often with a single conidiogenous locus, sometimes with sympodial proliferation and several loci, 1.5–2 µm diam., truncate to slightly convex, unthickened, but often distinctly darkened (pigmented). Conidia solitary, occasionally in short chains, ellipsoid-ovoid, fusiform, short subcylindrical, 10–25 × 4–7 µm, 0–3-septate [rarely with up to

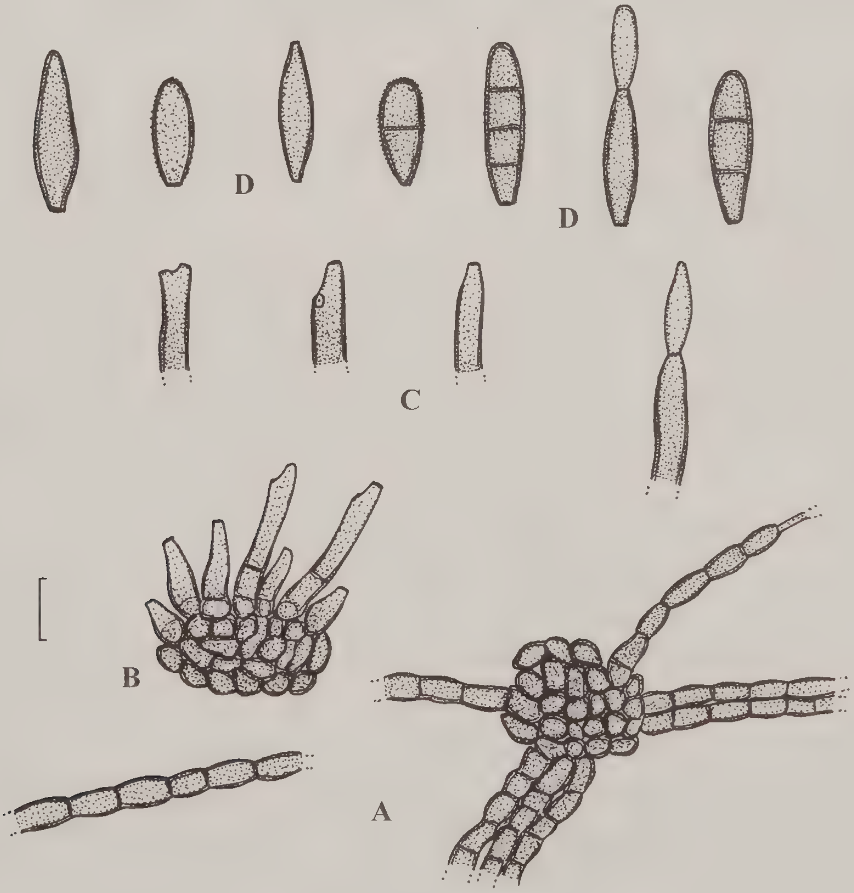

Fig. 3. *Fusicladium psammicola*.
A. Hyphae, hyphal aggregations and strands.
B. Fasciculate conidiophores. **C.** Conidiogenous cells. **D.** Conidia.
Scale bar = 10 µm. U. Braun *del.*

5 septa, according to Morgan-Jones & Kendrick (1972)], pale to medium brown or olivaceous-brown, wall thin to slightly thickened, smooth or almost so to faintly rough-walled, apex obtuse or somewhat attenuated, rarely subtruncate, base attenuated, with a truncate hilum, 1.5–2 µm diam., unthickened, but often distinctly darkened.

Comments: On account of clear differences between this species and the basic features of the genus *Exosporium* Link, Morgan-Jones & Kendrick (1972) reallocated *E. psammicola* to *Cladosporium* s. lat. However, due to the non-coronate conidiogenous loci and conidial hila, this species has to be excluded from *Cladosporium* s. str. The presence of subdenticulate, truncate, unthickened, but darkened-refractive scars suggests this species should be assigned to *Fusicladium* (Schubert et al. 2003), an assignment supported by the structure of the radiating hyphal strands and stromatic plates as well as the broad conidia, mostly formed singly. *Cladophialophora* is morphologically similar, but without cultures and molecular sequence analyses it is difficult to distinguish the two genera. However, characteristically radiating hyphal strands and stromatic plates are usually not formed in the latter genus, and the conidia are usually more slender and formed in long acropetal chains.

5. *Cladosporium indigoferae* Sawada,

Special Publ. Coll. Agric. Natl. Taiwan Univ. 8: 196. 1959, nom. inval. Fig. 4
= **fusicladium/cladophialophora-like**

Illustration: Sawada (1959: Pl. 3, Figs 8–9).

Material examined: TAIWAN. Pref. Taipei, Taipei, on dead stems of *Indigofera tinctoria* (*Fabaceae*), 18 Aug. 1909, K. Sawada (BPI 427230: type); Taiwan, 18 Aug. 1942, K. Sawada (PPMH: authentic material).

Colonies on dead stems, without any lesions (probably saprobic), punctiform, scattered or effuse, brown to blackish, somewhat velvety. Mycelium internal, forming one- to rarely multi-layered hyphal strands, composed of more or less globular, often somewhat inflated, 4–11 µm diam., smooth, thick-walled, olivaceous-brown cells, giving raise to conidiophores, but typical stromata lacking, additional hyphae smooth, 2–3 µm wide, paler. Conidiophores solitary or in small loose groups, arising from swollen hyphal cells or hyphal strands, erect, straight to somewhat curved, occasionally somewhat geniculate-sinuous, unbranched or rarely branched, 15–100(–146) × 3–4.5(–5) µm, septate, yellowish olivaceous-brown, wall smooth, slightly thickened; conidiogenous cells integrated, terminal or intercalary, 7–20 µm long, sympodial, with a single or few conidiogenous loci, truncate to slightly convex, 1–2 µm wide, barely thickened, but somewhat darkened-refractive. Conidia in branched chains, subglobose, ellipsoid-ovoid, cylindrical, straight, 4–26 × 3–5(–7) µm, 0–3-septate, not to somewhat constricted at the septa, pale olivaceous, wall

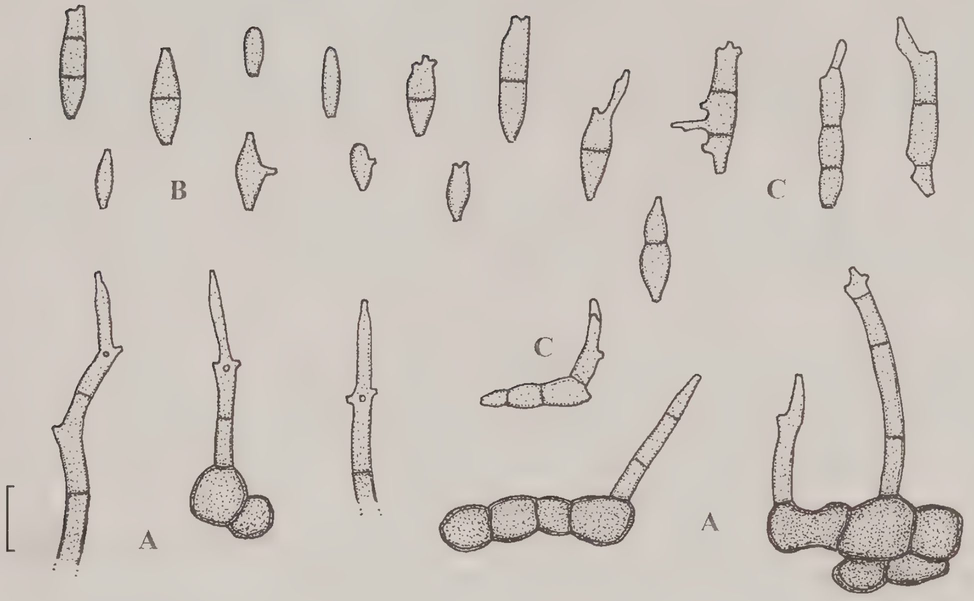

Fig. 4. *Cladosporium indigoferae*.
A. Conidiophores arising from swollen hyphal cells.
B. Conidia. C. Conidia (germination, with microcyclic conidiogenesis).
Scale bar = 10 µm. U. Braun *del.*

thin to slightly thickened, smooth, apex rounded to attenuated, base usually short obconically truncate, hila truncate, 1–2 µm diam., barely thickened, but somewhat darkened-refractive. Microcyclic conidiogenesis observed.

COMMENT: *Cladosporium indigoferae* is an invalid name, published without a Latin description. The type material examined is rather sparse, but some conidiophores and conidia, morphologically agreeing with the features of *Fusicladium* and *Cladophialophora*, has been found. However, the material examined is in too poor a condition for a final treatment and validation, which should be based on cultural characteristics and supported by molecular DNA sequence analyses.

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Literature cited

Braun U, Crous PW, Dugan F, Groenewald JZ, de Hoog GS. 2003. Phylogeny and taxonomy of *Cladosporium*-like hyphomycetes, including *Davidiella* gen. nov., the teleomorph of *Cladosporium* s. str. Mycological Progress 2: 3-18.

Braun U, Schubert K. 2007. Taxonomic revision of the genus *Cladosporium* s. lat. 7. Descriptions of new species, a new combination and further new data. Schlechtendalia 16: 61-76.

Crous PW, Braun U, Schubert K, Groenewald JZ. 2007a. Delimiting *Cladosporium* from morphologically similar genera. Studies in Mycology 58: 33-56.

Crous PW, Braun U, Schubert K, Groenewald JZ, eds. 2007b. The genus *Cladosporium* and similar dematiaceous hyphomycetes. Studies in Mycology 58: 1-253.

Crous PW, Schubert K, Braun U, de Hoog GS, Hocking AD, Shin H-D, Groenewald JZ. 2007c. Opportunistic, human-pathogenic species in the *Herpotrichiellaceae* are phenotypically similar to saprobes and phytopathogenic species in the *Venturiaceae*. Studies in Mycology 58: 185-217.

David J. 1997. A contribution to the systematics of *Cladosporium*. Revision of the fungi previously referred to *Heterosporium*. Mycological Papers 172: 1-157.

Dugan FM, Schubert K, Braun U. 2004. Check-list of *Cladosporium* names. Schlechtendalia 11: 1-103.

Ellis MB. 1976. More Dematiaceous Hyphomycetes. CMI, Kew.

Ellis MB, Ellis JP. 1985. Microfungi on Land Plants. An Identification Handbook. New Enlarged Edition. The Richmond Publishing Co., Ltd., Slough.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum, Part. 1: The Herbaria of the World. 8th edn. Regnum vegetabile 120: 1-163.

Heuchert B, Braun U, Schubert K. 2005. Morphotaxonomic revision of fungicolous *Cladosporium* species (hyphomycetes). Schlechtendalia 13: 1-78.

Morgan-Jones G, Kendrick B. 1972. Notes on Hyphomycetes. III. Redisposition of six species of *Exosporium*. Canadian Journal of Botany 50: 1817-1824.

Sawada K. 1959. Descriptive catalogue of Taiwan (Formosan) fungi XI. Special Bulletin, College of Agriculture, National Taiwan University 10: 1-268.

Schubert K. 2005a. Taxonomic revision of the genus *Cladosporium* s. lat. 3. A revision of *Cladosporium* species described by J.J. Davis and H.C. Greene (WIS). Mycotaxon 92: 55-76.

Schubert K. 2005b. Morphotaxonomic revision of foliicolous *Cladosporium* species (hyphomycetes). Thesis, Martin-Luther-University Halle-Wittenberg.

Schubert K, Braun U. 2004. Taxonomic revision of the genus *Cladosporium* s. lat. 2. Morphotaxonomic examination of *Cladosporium* species occurring on hosts of the families *Bignoniaceae* and *Orchidaceae*. Sydowia 56: 296-317.

Schubert K, Braun U. 2005a. Taxonomic revision of the genus *Cladosporium* s. lat. 1. Species reallocated to *Fusicladium*, *Parastenella*, *Passalora*, *Pseudocercospora* and *Stenella*. Mycological Progress 4: 101-109.

Schubert K, Braun U. 2005b. Taxonomic revision of the genus *Cladosporium* s. lat. 4. Species reallocated to *Asperisporium*, *Dischloridium*, *Fusicladium*, *Passalora*, *Pseudoasperisporium* and *Stenella*. Fungal Diversity 20: 187-208.

Schubert K, Braun U. 2007. Taxonomic revision of the genus *Cladosporium* s. lat. 6. New species, reallocations to and synonyms of *Cercospora*, *Fusicladium*, *Passalora*, *Septonema* and *Stenella*. Nova Hedwigia 84: 189-208.

Schubert K, Braun U, Groenewald JZ, Crous PW. 2007a. *Cladosporium* leaf-blotch and stem rot of *Paeonia* spp. caused by *Dichocladosporium chlorocephalum* gen. nov. Studies in Mycology 58: 95-104.

Schubert K, Groenewald JZ, Braun U, Dijksterhuis J, Starink M, Hill CF, Zalar P, de Hoog GS, Crous PW. 2007b. Biodiversity in the *Cladosporium herbarum* complex (*Davidiellaceae*, *Capnodiales*), with standardisation of methods for *Cladosporium* taxonomy and diagnostics. Studies in Mycology 58: 105-156.

Schubert K, Braun U, Mułenko W. 2006. Taxonomic revision of the genus *Cladosporium* s. lat. 5. Validation and description of new species. Schlechtendalia 14: 55-83.

Schubert K, Ritschel A, Braun U. 2003. A monograph of *Fusicladium* s. lat. (hyphomycetes). Schlechtendalia 9: 1-132.

Trail JWH. 1889. Fungi of Inverary II. Micromycetes. Scottish Naturalist (Perth) 4: 57-76.

MYCOTAXON

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Polypores new to Israel — 1: Genera Ceriporiopsis, Postia and Skeletocutis

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Abstract — *Ceriporiopsis balaenae, Postia rancida, P. subcaesia,* and *Skeletocutis percandida* are described and their microstructural features are illustrated according to new material collected in northern Israeli forests. Their distribution, habitat, and taxonomic relationships with other species are discussed.

Key words — Mediterranean, annual tinder fungi, diversity, taxonomy

Introduction

This paper is the first in a series devoted to the study of rare polypores in or new to Israel and contains information on four species from the genera *Ceriporiopsis* Domański, *Postia* Fr., and *Skeletocutis* Kotl. et Pouzar. These genera comprise a lot of annual non-stipitate polypores that have long been attributed to the large genus *Tyromyces* P. Karst. The taxonomy of this unclear genus is rather complicated, and "…its analysis requires much more detailed knowledge of the tropical species" (Corner 1989). In currently accepted taxonomy, the generic delimitation is based mainly on the presence of fiber hyphae in *Skeletocutis*, while fiberless *Postia* and *Ceriporiopsis* are distinguishable on the basis of basidiospore, basidium and hyphal morphology as well as the type of rot produced, with brown rot characteristic only to *Postia* within the group. The rest of *Tyromyces* remains an assemblage of subdimitic, white rot-producing, sessile polypores, related to *Panus* Fr. on the one hand, and to *Phlebia* Fr. on the other (Corner 1989, Spirin & Zmitrovich 2003).

Seven *Postia* species have been previously reported for Israel by Binyamini (1981) within the boundaries of the traditionally accepted genus *Tyromyces*, namely, *T. fragilis* (Fr.) Donk, *T. floriformis* (Quél.) Bondartsev & Singer, *T. stypticus* (Pers.) Kotl. & Pouzar, *T. mappa* (Overh. & J. Lowe) Ryvarden, *T. tephroleucus* (Fr.) Donk, *T. hibernicus* (Berk. & Broome) Ryvarden, and *T. lacteus* (Fr.) Murrill. Most of these descriptions were repeated in the book "Larger Fungi of Israel (*Ascomycotina* and *Basidiomycotina*)" (Binyamini 1984). At a later date, two other species – *Tyromyces balsameus* (Peck) Murill (Binyamini 1987) and *Postia inocybe* (A. David & Malençon) Jülich (Czederpiltz et al. 2004) – were added to the list of Israeli *Postia* (in the modern sense of this generic name). Here, *Postia rancida* and *P. subcaesia* are treated as new for Israel.

The genus *Ceriporiopsis* was previously not known in Israel; the presence of *Ceriporiopsis balaenae* is indicated in the humid oak forests of Golan Heights. *Skeletocutis percandida* is widely distributed in the West Mediterranean (Ryvarden & Gilbertson 1994); its easternmost locality is reported below.

Material and methods

Morphological characteristics of our specimens were examined by using a light/dark field microscope (Carl Zeiss Axiostar 1122-100). Measurements were taken using an immersion objective; a total of 30 spores from each specimen were measured. In order to prevent a variation of spore size, 5% of measurements were excluded from the end of each size variation range and are given in parentheses. Potassium hydroxide solution 10% (KOH) and medicinal iodine were used for microscopical analyses. A map (Fig. 1) showing the natural regions of Israel was used in order to demonstrate each new found species distribution. The material used in our analyses can be found in the herbarium of the Institute of Evolution, University of Haifa (HAI, Haifa, Israel).

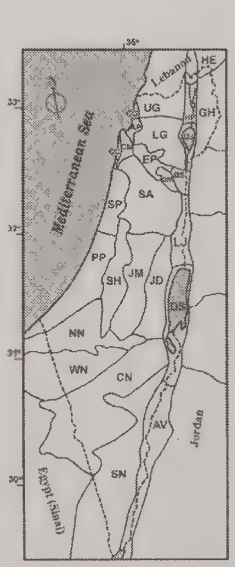

Fig. 1. Accepted abbreviations of nature regions of Israel: **AP** – Akko Plain; **AV** – Arava Valley; **BS** – Beit Shean Valley; **CC** – Carmel Coast; **CG** – Coast Galilee; **CM** – Carmel Mount; **CN** – Central Negev; **DS** – Dead Sea Area; **EP** – Esdraelon (Yizre'el) Plain; **GH** – Golan Heights; **GM** – Gilboa Mount; **HE** – Hermon Mount; **HP** – Hula Plain; **JD** – Judean Desert; **JM** – Judean Mts.; **LG** – Lower Galilee; **LJ** – Lower Jordan Valley; **NN** – Northern Negev; **PP** – Philistean Plain; **SA** – Samaria; **SH** – Shefela; **SN** – South Negev; **SP** – Sharon Plain; **UG** – Upper Galilee; **UJ** – Upper Jordan Valley; **WN** – Western Negev (Feinbrun-Dothan et al. 1998).

Taxonomic descriptions

Ceriporiopsis balaenae Niemelä, Nat. Canad. 112: 449 (1985). FIG. 2
≡ *Porpomyces balaenae* (Niemelä) Spirin & Zmitr., Karstenia 43: 80 (2003).

Basidiocarps resupinate, annual, soft when fresh, hard when dry (dry specimen), adnate. Hymenophore poroid, as a single tube layer up to 3 mm thick, pores angular, irregular, 1–2 per mm, honey-yellow, with slightly dentate dissepiments. Margin narrow, mucedinous and somewhat lighter than remaining fruitbody. Context whitish and very thin (barely observable), up to 0.3 mm thick. Hyphal system monomitic. Hyphae hyaline, with clamps, thin- to slightly thick-walled, branched, 2–4 µm broad (Fig. 2c). Cystidia or other sterile elements lacking. Basidia clavate with a basal clamp, 7–25 × 4–5 µm (Fig. 2b). Basidiospores ellipsoid to subglobose, smooth, hyaline and thin-walled, (3.4–)3.5–4.9 × (1.9–)2–3.5(–3.6) µm, non-amyloid (Fig. 2a).

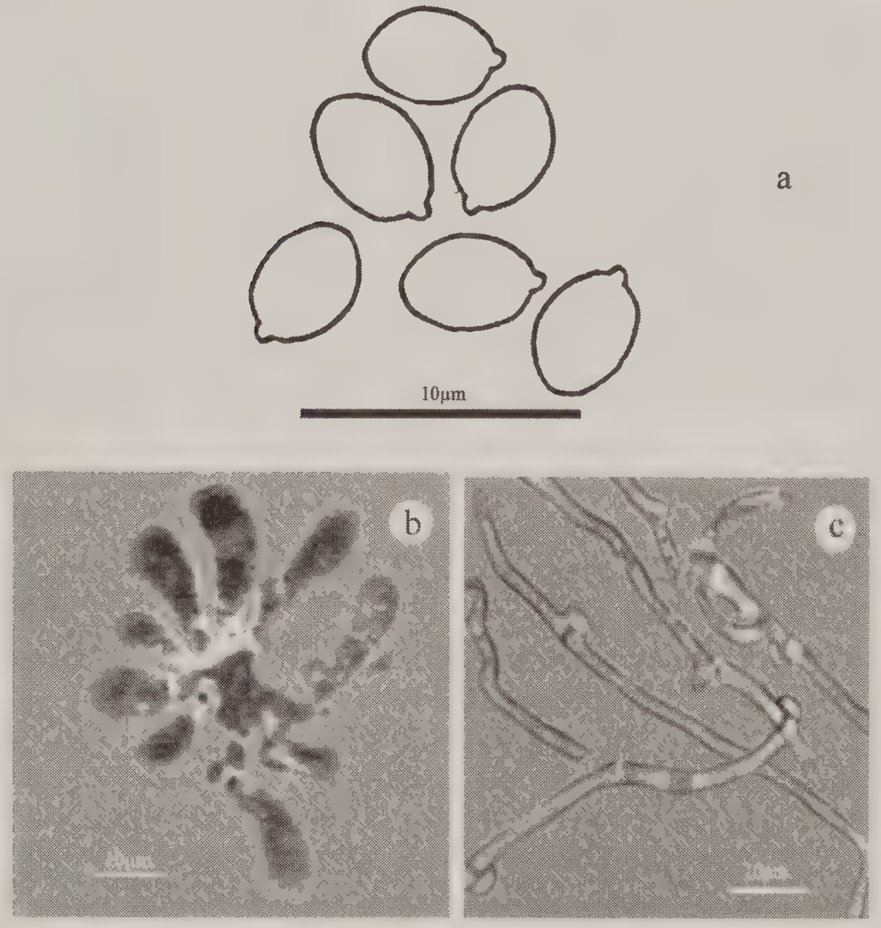

Fig. 2. *Ceriporiopsis balaenae* (HAI 0109).
a – basidiospores, *b* – basidia, *c* – contextual hyphae.

General distribution and habitat: *Ceriporiopsis balaenae* is a rare species, originally described from Canada (Niemelä 1985). Nowadays, its scarce distribution includes: Europe (Finland, France, Sweden, Russia, Czech

Republic, Slovakia); Asia (Russian Far East, Israel – Fig. 3); also known from the Caribbean (Puerto Rico).

Note: Being associated with a white rot, *C. balaenae* can be easily distinguished in the field due to white or cream-colored resupinate basidiocarps, soft consistence (when fresh) and turning honey-colored on drying. Its closest relative is, evidently, the East-Asian *C. cremea* (Parmasto) Ryvarden (Vampola & Pouzar 1996, Spirin & Zmitrovich 2003), which differs in having strongly cordonic basidiocarps and somewhat longer spores (up to 5.4 µm long according to Spirin & Zmitrovich 2003, up to 6 µm – according to Kinnunen & Niemelä 2005). The other closely related taxon is *C. consobrina* (Bres.) Ryvarden. According to Vampola (Vampola, pers. com. 2008), *C. balaenae* is very closely related to *C. consobrina*, distributed in the Mediterranean. We refer our material to *C. balaenae*, primarily based on spore shape and size (the spores of *C. consobrina* are somewhat wider and subglobose). More comprehensive studies are needed for this species complex.

SPECIMENS EXAMINED: *Ceriporiopsis balaenae*. **ISRAEL. Golan Heights:** Massada, mixed forest of *Quercus calliprinos* and *Q. boissieri*, on deciduous wood, 10.11.2006, leg. Y. Ur, det. I.V. Zmitrovich, D. Ţura and V.F. Malysheva (HAI 0109); Bar'am, mainly *Quercus calliprinos* forest, on oak bark, 09.03.2007, leg. & det. I.V. Zmitrovich, D. Ţura and V. Malysheva (HAI 0110). **CANADA. Québec:** Poste-de-la-Baleine, *Salix planifolia*, 12.08.1982, leg. & det. T. Niemelä (H, holotype). **RUSSIA. Leningrad Reg.:** Lisino, *Salix caprea*, 03.09.1960, leg. M.A. Bondartseva, det. W.A. Spirin & I.V. Zmitrovich (LE 19420). **FINLAND. Inarin Lappi:** Utsjoki, *Salix*, 16.08.1987, leg. & det. H. Kotiranta (H, dupl. in LE).

Ceriporiopsis cremea. **RUSSIA. Kamchatka:** Klyuchi, *Populus suaveolens*, 18.08.1960, leg. & det. E. Parmasto (TAA 13599, isotype in LE).

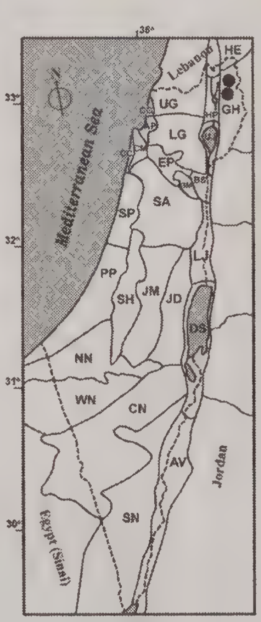

Fig. 3. Distribution of *Ceriporiopsis balaenae* in Israel.

Postia rancida (Bres.) M.J. Larsen & Lombard, Mycotaxon 26: 272 (1986). FIG. 4

≡ *Poria rancida Bres.*, Fung. Trident. 2: 96 (1900).

Basidiocarps resupinate, soft, with rancid taste (fresh material). Hymenophore poroid, as a single tube layer up to 5 mm thick. Pore surface white to pale cream, pores angular, 3–4 per mm, with slightly dentate dissepiments. Context white, present as a thin layer up to 1 mm thick. Margin white, cottony and thinning outwards. Hyphal system monomitic. Tramal hyphae hyaline, clamped, richly branched and thin-walled, 2–4 µm wide; contextual hyphae sparingly branched, thin-walled and broader (up to 5 µm across) than ones in tube trama (Fig. 4c). Cystidia not seen. Basidia clavate with a basal clamp, 15–21 × 3–7

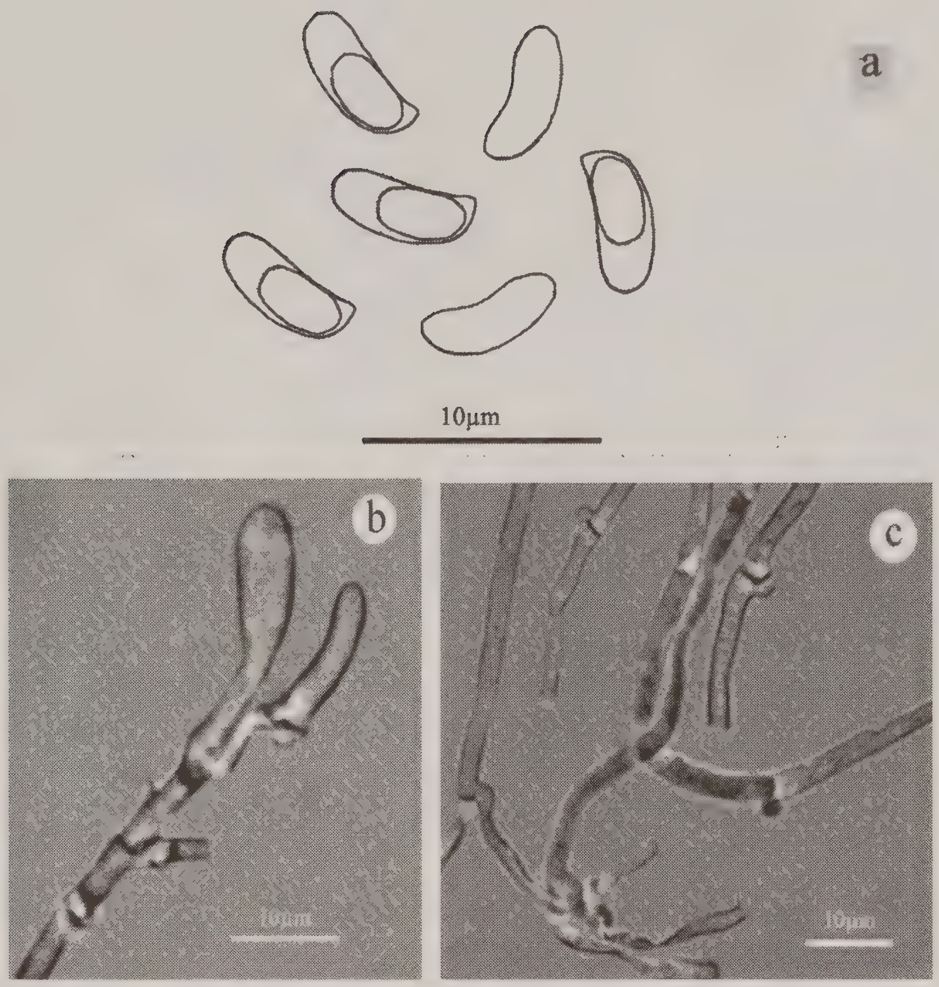

Fig. 4. *Postia rancida* (HAI 0108).
a – basidiospores, *b* – basidia, *c* – contextual hyphae.

μm (Fig. 4b). Basidiospores cylindrical, smooth, thin-walled, with oil-drops inside (usually one large oil-drop in the middle part of the spore), 5.9–7.9 × (1.9–)2–3(–3.1) μm, non-amyloid, acyanophilous (Fig. 4a).

General distribution and habitat: *Postia rancida* occurs mostly in coniferous forests, growing on dead wood of *Pinus* and *Picea*, and more rarely in hardwood forests. Associated with a brown cubical rot. *P. rancida* is a rare species, its general distribution includes: Europe (England, Norway, Italy, Poland); North America (USA); Asia (Israel – Fig. 5, China).

Note: *Postia rancida* can be easily confused with other species of this genus. The main reliable feature of this polypore is the spore size. However, *P. rancida* might be confused with a closely related species *Rhodonia placenta* (Fr.) Niemelä et al. (Niemelä et al. 2005). The spores of the latter are quite similar to those of *P. rancida*, and its common bright rose color is absent in some collections, replaced by cream, pale-lilac or even ochraceous tints. Renvall (Ryvarden & Gilbertson 1994) was of the opinion that *P. rancida* could be a pale form of *Rhodonia placenta*. Further studies are needed to clarify the identity of these species. In comparison to other *Postia* species, *P. rancida* is the closest relative of *Postia mappa* (Overh. & J. Lowe) M.J. Larsen & Lombard, which also occurs in Israel. Both species are very similar, but *P. mappa* has slightly larger spores (6.5–8.5 µm long) and 1–3 pores per mm. *P. rancida* and *P. mappa* were discussed by Spirin et al. (2006) as possible members of *Rhodonia*.

SPECIMENS EXAMINED: *Postia rancida*. ISRAEL. **Upper Galilee:** Biriya, *Pinus halepensis* forest, on coniferous cone, 07.03.2007, leg. & det. I.V. Zmitrovich, D. Țura and V.F. Malysheva (HAI 0108).

Postia mappa. ISRAEL. **Judean mountains:** Shaar Hagai, *Pinus* sp. forest, on dry branches of pine, 26.01.1981, leg. & det. N. Binyamini (TELA).

Rhodonia placenta. RUSSIA. **Nizhny Novgorod Reg.:** Kilemarsky Nat. Res., *Picea abies*, 17.08.2004, leg. & det. W.A. Spirin (H) (cream-coloured specimen). FINLAND. **Etelä-Häme:** Mustiala, *Pinus sylvestris*, 27.07.1892, leg. & det. P.A. Karsten (H, holotype of *Physisporus albolilacinus* P. Karst.).

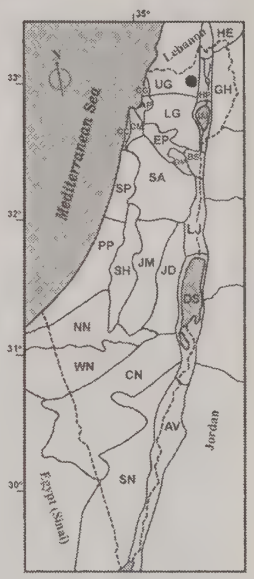

Fig. 5. Distribution of *Postia rancida* in Israel.

Postia subcaesia (A. David) Jülich, Persoonia 11: 424 (1982). **FIG. 6**

≡ *Tyromyces subcaesius A. David*, Bull. Soc. Linn. Lyon 43: 120 (1974).

Basidiocarp pileate to effused-reflexed. Pileus semicircular, ca 2 × 1 × 0.5 cm, soft in fresh condition, fragile when dry (Fig. 6a). Upper surface weakly zonate, minutely uneven, tomentose with small tufts of hyphae (barely seen with naked eye), middle part bluish (dark blue to blackish on drying). Margin white, thinning outwards. Hymenophore poroid, as a single layer up to 5 mm thick, concolorous with pore surface. Pores 4–5 per mm, white-grayish, angular. Context white, present as a thin layer up to 2 mm thick. Hyphal system monomitic. Generative hyphae hyaline, with clamps, branched, slightly sinuous, thin-walled to thick-walled, wider in the context (up to 5 µm across; Fig. 6d). Cystidia not seen. Basidia cylindrical to lageniform, with a basal clamp and 4 sterigmata, 11–15 × 3–4.5 µm (Fig. 6b). Basidiospores cylindrical to allantoid, smooth, hyaline, thin-walled with oil-drops inside (usually two droplets), 4.9–5.9 × (0.9–)1–1.5(–1.6) µm, non- or weakly amyloid; bluish-gray in mass (Fig. 6c).

General distribution and habitat: According to our current knowledge on the species limits within the *Postia caesia*-complex, *P. subcaesia* is known as growing on various hardwood substrates from: Europe (England, Ireland,

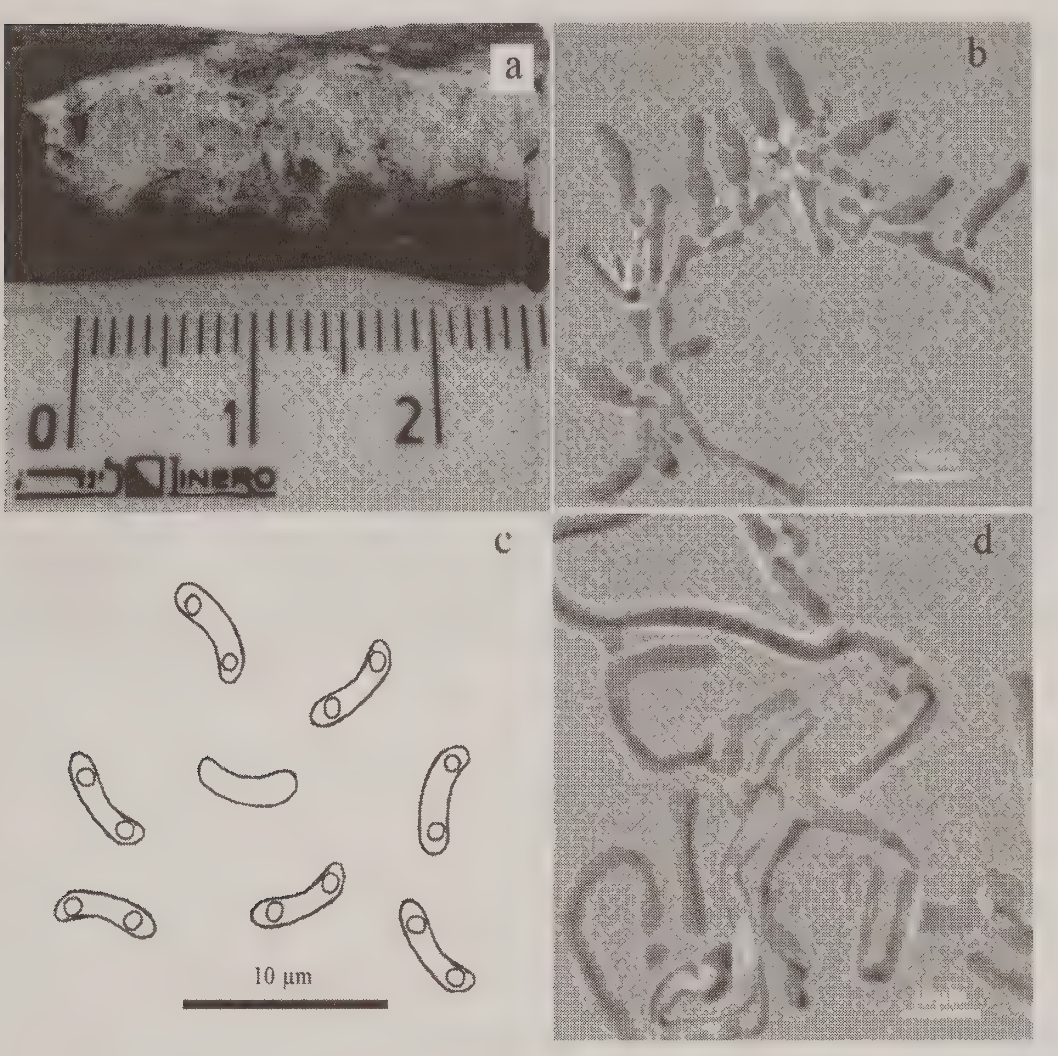

Fig. 6. *Postia subcaesia* (HAI 0107).
a – upper view of basidiocarps, *b* – basidia, *c* – basidiospores, *d* – contextual hyphae.

Norway, Czech Republic, Sweden, Germany, Switzerland, France, Denmark, Italy, Belgium, Poland, Ukraine, the Netherlands, Slovakia, Hungary, Greece, Russia); ASIA (Israel – Fig. 7, India, China); NORTH AMERICA (USA, Canada).

NOTE: Members of the *Postia caesia*-complex have an isolated position within the genus *Postia*. All are bluish, medium- to small-sized polypores causing a brown rot; the species do not produce chlamydospores in culture (David 1980), and their basidiospores are faintly amyloid. The name *Cyanosporus* McGinty might be applied to this group (Pieri & Rivoire 1998) if raised to generic rank.

There are many difficulties with the species limits in this complex. David (1974, 1980) was the first to split *P. caesia* sensu lato into separate species; other species were added later by Niemelä et al. (2001) and Pieri & Rivoire (2005). *Postia subcaesia* and *P. alni* Niemelä & Vampola belong to the narrow-spored species within the *Postia caesia* complex (spore width does not exceed 1.5 µm), while *P. caesia* (Schrad.) P. Karst. s. str., *P. luteocaesia* (A. David) Jülich, and *P. mediterraneocaesia* M. Pieri & B. Rivoire constitute the wide-spored group (spore width mostly more than 1.5 μm). *Postia alni*, the closest relative of *P. subcaesia*, differs by its smaller fruitbodies and matted upper surface; its tramal hyphae swell inwards and become gelatinized in KOH. However, there are some confusing East-Asian collections that do not fit well with both *P. alni* and *P. subcaesia*. Recent molecular data (Yao et al. 2005) suggest that the taxonomy of this group should be more complicated than currently found.

SPECIMENS EXAMINED: **ISRAEL. Samaria:** Reihan, *Pinus halepensis* and *Quercus calliprinos* forest, on unidentified substrate, 19.02.2007, leg. Y. Ur, det. I.V. Zmitrovich, D. Ţura and V.F. Malysheva (HAI 0106). **Upper Galilee:** Meron, *Pinus halepensis* and *Quercus calliprinos* forest, on deciduous wood, 09.03.2007, leg. & det. I.V. Zmitrovich, D. Ţura and V.F. Malysheva (HAI 0107). **FRANCE. Isère:** region de Crémieu, *Malus*, 10.1968, leg. & det. A. David (H ex LY-AD 652, isotype of *Tyromyces subcaesius*). **Mère Boitier:** Saone et Loire, *Quercus*, 29.07.1965, leg. & det. A. David (H ex LY-AD 150).

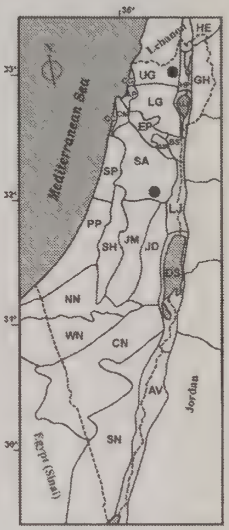

Fig. 7. Distribution of *Postia subcaesia* in Israel.

Skeletocutis percandida (Malençon & Bertault) Jean Keller,
Persoonia 10: 353 (1979). **FIG. 8**

≡ *Poria percandida* Malençon & Bertault, Acta Phytotax. Barcinon. 8 : 35 (1971).

Basidiocarp annual, resupinate, sprawled on wood as a thin layer, up to 1–1.5 mm thick, soft when fresh, hard when dry (dry specimen), peelable (Fig. 8). Hymenophore poroid, as a single whitish tube layer up to 0.5 mm thick. Pores round, 3–4 per mm, with slightly thick dissepiments, pore surface white to cream with fine pinkish tint. Margin white, thin, byssoid to cordonic, broadly sterile. Context very thin, cottony, white-colored. Hyphal system dimitic. Generative hyphae hyaline with clamps, branched, easily encrusted, thin- to thick-walled, 2–3 μm wide. Skeletal hyphae hyaline, sinuous, sparingly branched and thick-walled, 2–5 μm wide. Cystidia not seen, but fusoid cystidioles are present in the hymenium. Basidia ovoid to clavate, 15–20 × 5–7 μm, with a basal clamp and 4 sterigmata. Basidiospores cylindrical (slightly curved), hyaline, smooth, thin-walled with oil drops inside, (6.4–)6.5–8 × 2–3(–3.1) μm, non-amyloid.

General distribution and habitat: *Skeletocutis percandida* is widely distributed in the Mediterranean (David 1982, Vampola & Forstinger 1993, Bernicchia 2005, Pieri & Rivoire 2007). To the best of our knowledge, its general distribution includes: Europe (Italy, France, Spain, Portugal, Greece); Asia (China, Israel – Fig. 9); Africa (Zimbabwe).

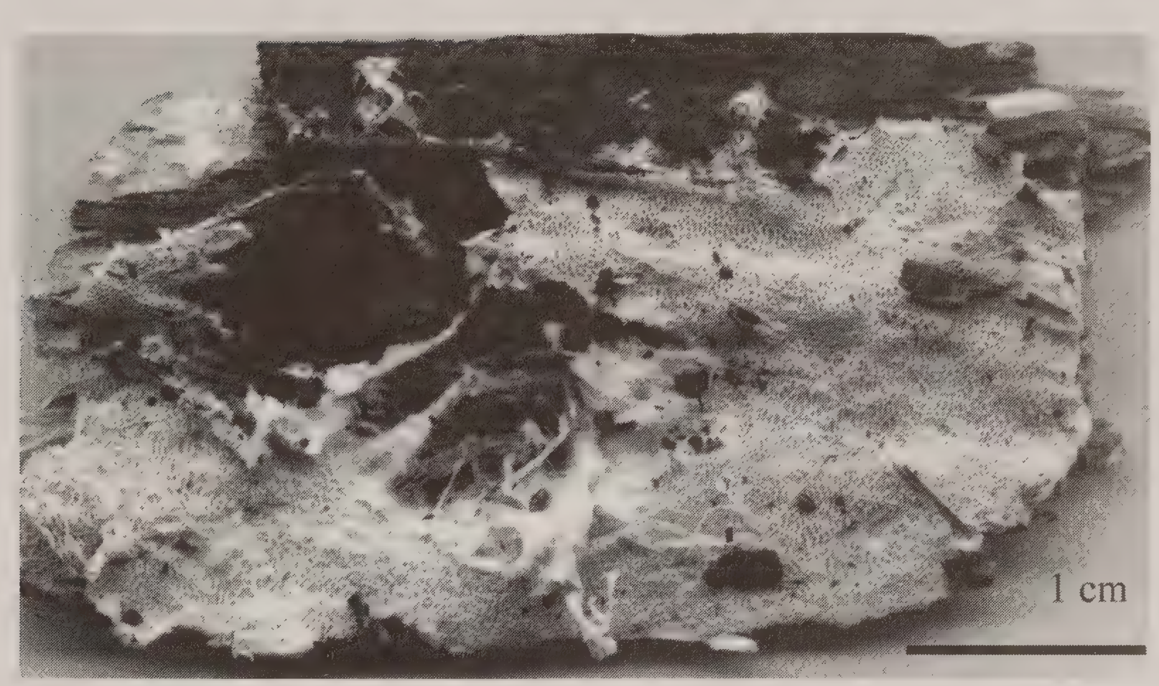

Fig. 8. *Skeletocutis percandida* (HAI 0111)effused basidiocarp with byssoid cordonic margin.

Note: This species is thoroughly described by David (1982) and Niemelä (1998). It is characterized by strongly cordonic basidiocarps and relatively long cylindrical spores 4.9–7.2 × 2.2–2.8 µm. *S. alutacea* (J. Lowe) Jean Keller is another cordonic *Skeletocutis* species known in the Northern Hemisphere; but differs by smaller pores and spores (Niemelä 1998, Spirin 2005). An apical incrustation on skeletal hyphae occurs at the dissepiments edges in both *S. alutacea* and *S. percandida*; this feature is not reported for other *Skeletocutis* species (only generative hyphae are encrusted), except *S. novae-zelandiae* (G. Cunn.) P.K. Buchanan & Ryvarden (Buchanan & Ryvarden 1988), which could be closely related to them. Taxonomy of these species is poorly worked-out.

SPECIMENS EXAMINED: Skeletocutis percandida. **ISRAEL. Upper Galilee:** Meron, *Pinus halepensis* and *Quercus calliprinos* forest, on coniferous wood, 09.03.2007, leg. I.V. Zmitrovich, D. Ţura and V.F. Malysheva, det. W.A. Spirin (HAI 0111). – Skeletocutis alutacea. **RUSSIA. Nizhny Novgorod Reg.:** Razino, *Pinus sylvestris*, 05.08.1998, leg. & det. W.A. Spirin (LE 208266).

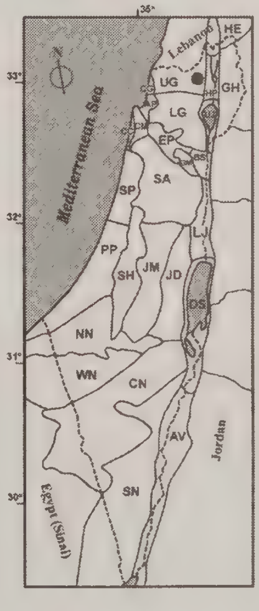

Fig. 9. Distribution of *Skeletocutis percandida* in Israel.

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Literature cited

Bernicchia A. 2005. Fungi Europaei (*Polyporaceae* s.l.). Alassio, Edizioni Candusso. 116 pp.

Binyamini N. 1981. Lignicolous *Aphyllophorales* fungi from Israel 1. Nova Hedwigia 35(2): 357–369.

Binyamini N. 1984. Larger fungi of Israel (*Ascomycotina* and *Basidiomycotina*). Ramot Publishing Co., Tel Aviv. Pp. 112–114.

Binyamini N. 1987. Addenda to the *Aphyllophorales* and *Tulasnellales* fungi from Israel 4. Nova Hedwigia 44: 365–372.

Buchanan PK, Ryvarden L. 1988. Type studies in the *Polyporaceae* 18. Species described by Cunningham. Mycotaxon 31: 1–38.

Corner EJH. 1989. Ad Polyporaceas V. The genera *Albatrellus*, *Boletopsis*, *Coriolopsis* (dimitic), *Cristelloporia*, *Diacanthodes*, *Elmerina*, *Fomitopsis (dimitic)*, *Gloeoporus*, *Grifola*, *Hapalopilus*, *Heterobasidion*, *Hydnopolyporus*, *Ischnoderma*, *Loweporus*, *Parmastomyces*, *Perenniporia*, *Pyrofomes*, *Steccherinum*, *Trechispora*, *Truncospora* and *Tyromyces*. Beih. Nova Hedwigia 96: 1–218.

Czederpiltz DLL, Wikler K, Radmacher RD, Volk TJ, Hadar Y, Micales J. 2004. Diversity of wood-inhabiting fungi in Israeli pine forests. Mem. New York Bot. Garden 89: 191–202.

David A. 1974. Une nouvele espèce de *Polyporaceae*: *Tyromyces subcaesius*. Bull. Soc. Linn. Lyon 43: 119–126.

David A. 1980. Étude du genre *Tyromyces* sensu lato. Bull. Soc. Linn. Lyon 49: 6–56.

David A. 1982. Étude monographique du genre *Skeletocutis*. Naturaliste Canadien 109: 235–272.

Kinnunen J, Niemelä T. 2005. North European species of *Ceriporiopsis* (*Basidiomycota*) and their Asian relatives. Karstenia 45: 81–90.

Niemelä T. 1985. Mycoflora of Poste-de-la-Baleine. Naturaliste Canadien 112: 445–472.

Niemelä T. 1998. The *Skeletocutis subincarnata* complex (*Basidiomycetes*), a revision. Acta Bot. Fennica 161: 1–35.

Niemelä T, Kinnunen J, Lindgren M, Manninen O, Miettinen O, Penttilä R, Turunen O. 2001. Novelties and records of poroid *Basidiomycetes* in Finland and adjacent Russia. Karstenia 41: 1–21.

Niemelä T, Kinnunen J, Larsson KH, Shigel DS, Larsson E. 2005. Genus revision and new combinations of some North European polypores. Karstenia 45: 75–80.

Pieri M, Rivoire B. 1996. A propos de quelques polypores (*Aphyllophoromycetideæ*) rares ou critiques récoltés recemment. Bull. trimest. Soc. mycol. France 112(3): 163–187

Pieri M, Rivoire B. 1998. *Postia inocybe* f. *inocybe* et f. *pileatus* f. nova. Notes nomenclaturales sur le genre *Postia*. Bull. trimest. Soc. mycol. France 114(3): 19–33.

Pieri M, Rivoire B. 2005. *Postia mediterraneocaesia*, une nouvelle espèce de polypore découverte dans le sud de l'Europe. Bull. FAMM. 28: 33–38.

Pieri M, Rivoire B. 2007. Inventaire des polypores des Îles Sainte Marguerite, Port Cros et Porquerolles, France. Bull. Soc. Linn. Lyon 76: 81–97.

Ryvarden L, Gilbertson RL. 1994. European Polypores 2. Oslo: Fungiflora.

Spirin W, Zmitrovich IV. 2003. Notes on some rare polypores, found in Russia 1. Karstenia 43: 67–82.

Spirin W. 2005. Notes on some rare polypores, found in Russia 2. Karstenia 45: 103–113.

Spirin W, Zmitrovich I, Wasser SP. 2006. *Oligoporus balsameus* – rare Eurasian species plus notes on some related taxa. Mycotaxon 97: 73–82.

Vampola P, Forstinger H. 1993. A new locality of *Skeletocutis percandida* – the island of Crete in the Mediterranean Sea. Micol. Veget. Mediterranea 8(1): 72–74.

Vampola P, Pouzar Z. 1996. Notes on some species of genera *Ceriporia* and *Ceriporiopsis* (*Polyporaceae*). Czech Mycol. 48: 315–324.

Yao YJ, Pegler DN, Chase MW. 2005. Molecular variation in the *Postia caesia* complex. FEMS Microbiol. Letters 242: 109–116.

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South Florida microfungi: a new species of *Stanjehughesia* (hyphomycetes) from *Sabal* palm

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Abstract—*Stanjehughesia floridensis* anam. sp. nov. is described and illustrated from rachides and petioles of dead leaves of *Sabal* sp. in southeastern Florida, USA. The fungus is characterized by conidiophores reduced to monoblastic, brown, cylindrical, ampulliform or lageniform, solitary or clustered conidiogenous cells and obclavate to cylindric-obclavate, smooth, brown, 5-9 euseptate conidia with dark bands at the septa. It is compared with morphologically similar taxa, and a synoptical table of accepted species of *Stanjehughesia* is provided.

Key words—anamorphic fungi, palm fungi, *Sporidesmium*

Introduction

During a short-term survey of saprophytic microfungi occurring on plant debris from southeastern Florida, an interesting hyphomycetous anamorph was abundantly collected on *Sabal* palm dead leaves. The fungus possesses conidiogenesis and conidial features that clearly suggest a placement within the genus *Stanjehughesia* Subram. (Subramanian 1992, Wu & Zhuang 2005), but morphologically differs from all previously known species. Therefore it is described here as new. The type specimen and other specimen examined are deposited in the Herbarium of the U. S. National Fungus Collections (BPI).

Taxonomic description

Stanjehughesia floridensis G. Delgado, anam. **sp. nov.** Figs. 1-6
Mycobank MB511313

Ad fungus anamorphicus, hyphomycetes, pertinens. Coloniae *in substrato naturali effusae, nigrae.* Mycelium *superficiale, ex hyphis ramosis, septatis, pallide brunneae vel brunneae, 1.5-2 µm latis compositum.* Conidiophora *absentia.* Cellulae conidiogenae *monoblasticae, determinatae, plerumque intercalares, cylindricae, ampulliformes vel lageniformes, erectae, rectae vel flexuosae, crassitunicatae, laevia, discretae vel gregares,*

> *brunneae vel atro-brunneae, 5-9 × 2-3.5 µm, ad basim 5-6 µm crassa, at apicem 1.5-2 µm crassa et truncatae.* CONIDIORUM SECESSIO *schizolytica.* CONIDIA *holoblastica, solitaria, sicca, acrogena, recta vel leviter curvata, obclavata vel cylindrico-obclavata, brunneae, laevia, 5-9 euseptata, leviter constricta ad septa, 32-48 × 6-7 µm, cellula apicalis rotundata vel leviter spatulata, pallide brunnea, cellula basalis obconica, saepe pallide brunneae, 5-7 × 4-4.5 µm, in hilum truncatum breviter attenuata.* TELEOMORPHOSIS *ignota.*
>
> HOLOTYPE — **UNITED STATES. FLORIDA: Broward Co.,** POMPANO BEACH, on rachides and petioles of dead leaves of *Sabal* sp., V.27.2007, coll. G. Delgado (BPI 878270).
>
> ETYMOLOGY — Latin, *floridensis*, referring to the state of Florida, where the fungus was collected.

Anamorphic fungi, hyphomycetes. COLONIES on natural substrate effuse, black. MYCELIUM superficial, composed of branched, septate, pale brown to brown hyphae, 1.5-2 µm wide. CONIDIOPHORES absent. CONIDIOGENOUS CELLS monoblastic, determinate, mostly intercalary, cylindrical, ampulliform or lageniform, erect, straight or flexuous, thick-walled, smooth, solitary or disposed in caespitose clusters to large extensive groups, brown to dark brown, 5-9 × 2-3.5 µm, 5-6 µm wide at the bulbous base, 1.5-2 µm wide at the truncate apex. CONIDIAL SECESSION schizolytic. CONIDIA holoblastic, solitary, dry, acrogenous, straight or slightly curved, obclavate to cylindric-obclavate, brown, smooth-walled, 5-9 euseptate, with dark bands and slightly constricted at the septa, 32-48 × 6-7 µm; apical cell rounded or slightly spathulate, light brown; basal cell obconical, often paler, 5-7 × 4-4.5 µm, tapered to a narrow, truncate hilum. TELEOMORPH unknown.

> OTHER SPECIMENS EXAMINED—UNITED STATES. FLORIDA: Broward Co., POMPANO BEACH, on rachides and petioles of dead leaves of *Sabal* sp., XI.2004, coll. G. Delgado (BPI 877806A).

Discussion

Subramanian (1992) reassessed the anamorphic genus *Sporidesmium* Link and introduced *Stanjehughesia* to accommodate a group of five species characterized by solitary, euseptate conidia and very reduced or absent conidiophores consisting of simple conidiogenous cells. Reblová (1999) did not accept Subramanian's arrangement, considering it to be schematic, diagnostically valuable but phylogenetically unacceptable. She preferred to retain the type species, *Stanjehughesia hormiscioides* (Corda) Subram. in *Sporidesmium*, as *Sp. hormiscioides* Corda. However, additional species have been described or transferred to *Stanjehughesia* following Subramanian's concept (McKenzie 1995, Mena et al. 2001, Wu & Zhuang 2005). Wu & Zhuang provided an account of the genus and described four species collected on bamboo culms and dead branches from China. They retained the specific name *St. vermiculata* (Cooke) Subram. (=*Sp. vermiculatum* (Cooke) M.B. Ellis) for a specimen collected on rotten wood and bark of *Fagus sylvatica* L. and *Quercus* sp. Hughes

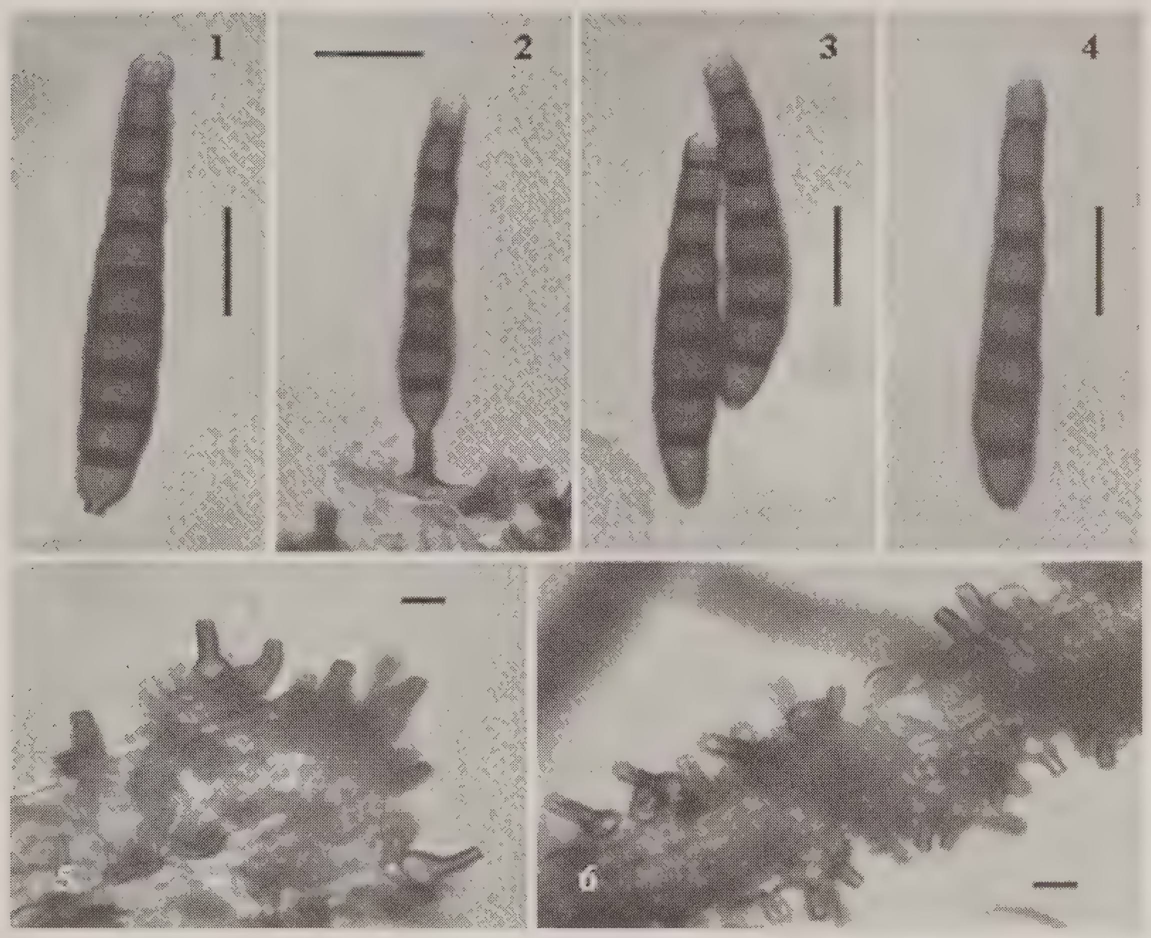

Fig. 1-6. *Stanjehughesia floridensis*, from holotype (BPI 878270). 1, 3-4. Conidia. 2. Conidium attached to a conidiogenous cell. 5-6. Conidiogenous cells on natural substrate.
Scale bars: 1-4 = 10 µm; 5-6 = 5 µm.

(1958) previously considered *Sp. vermiculatum* and *Sp. caespitulosum* (Ellis & Everh.) M.B. Ellis (=*St. caespitulosa* (Ellis & Everh.) Subram.) to be synonyms of *Sp. hormiscioides* (=*St. hormiscioides*). The descriptions and illustrations provided by Ellis (1958, 1976) show that *Sp. vermiculatum* and *Sp. hormiscioides* are remarkably similar and should be considered conspecific under their current placement in *Stanjehughesi*a, whereas *St. caespitulosa* differs enough to be retained as a separate species. Reblová (1999) also discussed the variations in conidiophore morphology of another species, *St. larvata* (Cooke & Ellis) Subram. (=*Sp. larvatum* Cooke & Ellis) under natural and culture conditions, retaining the latter name for the anamorph of *Miyoshiella larvata* Reblová. Several collections having distinct, macronematous, multicelled conidiophores and 0-1 proliferating conidiogenous cells support Reblová's opinion to maintain this anamorph in *Sporidesmium* (Hughes & Illman 1974, Matsushima 1975, Reblová 1999, Wu & Zhuang 2005).

Recent phylogenetic studies suggest that *Sporidesmium* and morphologically similar genera including *Stanjehughesia* are a polyphyletic, artificial assemblage

Table 1. Morphological features of accepted species of *Stanjehughesia*.

Species	Conidiophores	Conidiogenous cells		Conidia			
		Shape	Size (mm)	Shape	Septation	Wall texture	Size (mm)
St. caespitulosa	Absent	Bulbous	12-15 × 8-11	Cylindrical to subfusiform	8-20 eusepta	Smooth	65-150 × 13-17
St. decorosa	Present, reduced	Cylindrical	20-30 × 10-15	Obclavate	10-14 euseptate	Verrucose, striated	170-200 × 12-17
St. fasciculata	Present, reduced	Obclavo-cylindrical to obclavate	Up to 30	Obclavate or fusiform	9-15 euseptate, 1-2 distoseptate at the apex	Verruculose	60-118 × 7-11
St. floridensis	Absent	Cylindrical, ampulliform or lageniform	5-9 × 2-3.5	Obclavate to cylindric-obclavate	5-9 euseptate	Smooth	32-48 × 6-7
St. fusiformis	Absent	Cylindrical to ampulliform	11-15 × 5-7	Fusiform, obclavate to obclavate-rostrate	6-8 euseptate	Smooth	65-85 × 7-8
St. hamatiella	Absent	Cylindrical to ampulliform	7-14 × 5-7	Obclavate to obclavate-rostrate and hamate	11-14 euseptate, 6-9 distoseptate	Smooth	70-140 × 7-8.5
St. hormiscioides	Absent	Obclavate to flask shape	10-25 × 5-11	Subcylindrical to cylindric-fusoid	12-26 euseptate	Smooth	65-270 × 10-17
St. minima	Absent	Cylindrical to ampulliform	8-11 × 2-3.5	Fusiform or ellipsoidal	6-8 euseptate	Smooth	34-48 × 8.5-10
St. nigroacus	Absent	Lageniform to doliiform	8-14 × 7-12	Acicular	23-36 euseptate	Smooth	130-214 × 10-12
St. polypora	Absent	Cylindrical to ampulliform	13-18 × 3.5-5	Fusiform, obclavate to obclavate-rostrate	15-20 euseptate	Smooth	110-165 × 10-12

of unrelated anamorphs with affiliations to *Dothideomycetes* and *Sordariomycetes*, and the morphological characters currently used to delimit the genera are not phylogenetically significant (Shenoy et al. 2006). In the present case however, Subramanian's concept of *Stanjehughesia* is followed and considered valid for diagnostic purposes, until further investigations continue refining the taxonomic status and phylogenetic relationships among *Sporidesmium* and related anamorphs (Shenoy et al. 2007). Accordingly, *Stanjehughesia* would currently comprise ten species, whose morphological features are compared in Table 1.

Some *Stanjehughesia* species fit well with the generic concept of *Janetia* sensu Goh & Hyde (1996). These authors formally expanded the original concept of Ellis (1976), based on *Janetia euphorbiae* M.B. Ellis, to include species producing obclavate or cylindrical, euseptate or distoseptate conidia borne on monoblastic and/or polyblastic denticulate conidiogenous cells on usually integrated and single conidiophores, but also aggregated in synnematal conidiomata. Despite the morphological similarities, *Stanjehughesia* species can be separated from *Janetia* on the basis of their monoblastic, non-denticulate conidiogenous cells and lignicolous habitat (Mena et al. 2001, Wu & Zhuang 2005).

Stanjehughesia floridensis is morphologically close to *St. caespitulosa* and *St. hormiscioides* (Ellis 1958, 1976), which also have smooth-walled, brown conidia with dark bands associated with the septa. They also share similarly shaped conidiogenous cells that are solitary or disposed in caespitose clusters to large groups, terminally and laterally arranged on the hyphae. However, *St. caespitulosa* has cylindrical to subfusiform, 8-20 euseptate, larger conidia (65-150 × 13-17 μm) and larger conidiogenous cells (12-15 × 8-11 μm). *St. hormiscioides* is distinguished from the new species by its clavate when young, fusiform when mature, also larger conidia (65-270 × 10-17 μm), with 12-26 septa, and larger conidiogenous cells (10-25 × 5-11 μm). Another species, *St. minima* W.P. Wu (Wu & Zhuang 2005) resemble *St. floridensis* in conidial length, texture, color, number of septa and the morphology of conidiogenous cells, but differs in having fusiform or ellipsoidal, wider conidia (8.5-10 μm) without dark bands at the septa.

Among species of *Janetia* with similar conidial morphology, *J. euphorbiae* (Ellis 1976) could be compared with *St. floridensis*, but the presence of polyblastic conidiogenous cells usually bearing 2-4 thick denticles and 3-6 septate, shorter conidia (18-36 μm) clearly separate both taxa. *Janetia capnophila* S. Hughes (Hughes 1983) is also morphologically close to *St. floridensis* in having inflated, constantly monoblastic conidiogenous cells and narrowly obclavate conidia that are rounded at the apex and conico-truncate at the base. However, *J. capnophila* has (7-)9-13(-16) septate, larger conidia (80-125(-145) × 10.8-13.5(-16.2) μm), with conspicuously darker basal cells and up to 7 conidial cells that may become conidiogenous. It also occurs intimately associated with sooty moulds, developing a thin, sparse, irregular network of hyphae on leaf surfaces.

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Literature cited

Ellis MB. 1958. *Clasterosporium* and some allied *Dematiaceae - Phragmosporae*. I. Mycol. Pap. 70: 1-89.

Ellis MB. 1976. More dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, UK. 507 pp.

Goh TK, Hyde KD. 1996. *Janetia curviapicis*, a new species, and an emended description of the genus. Mycologia 88: 1014-1021.

Hughes SJ. 1958. Revisiones hyphomycetum aliquot cum appendice de nominibus rejiciendis. Can. J. Bot. 36: 727–836.

Hughes SJ. 1983. New Zealand Fungi 32. *Janetia capnophila* sp. nov. and some allies. New Zealand J. Bot. 21:177-182.

Hughes SJ, Illman WI. 1974. *Sporidesmium larvatum*. Fungi Canadenses 59: 1-2.

Matsushima T. 1975. Icones microfungorum a Matsushima lectorum. Published by the author, Kobe, Japan. 209 pp.

McKenzie EHC. 1995. Dematiaceous hyphomycetes on *Pandanaceae*. 5. *Sporidesmium* sensu lato. Mycotaxon 56: 9-29.

Mena J, Delgado G, Mercado A, Gené J, Guarro J, Iacona V. 2001. New or interesting hyphomycetes from the Biosphere Reserve of Sierra del Rosario, Cuba. Mycologia 93: 751-757.

Reblová M. 1999. Studies in *Chaetosphaeria* sensu lato III. *Umbrinosphaeria* gen. nov. and *Miyoshiella* with *Sporidesmium* anamorphs. Mycotaxon 71: 13-43.

Shenoy BD, Jeewon R, Hyde KD. 2007. Impact of DNA sequence-data on the taxonomy of anamorphic fungi. Fungal Diversity 26: 1-54.

Shenoy BD, Jeewon R, Wu WP, Bhat DJ, Hyde KD. 2006. Ribosomal and RPB2 DNA sequence analyses suggest that *Sporidesmium* and morphologically similar genera are polyphyletic. Mycol. Res. 110: 916-928.

Subramanian CV. 1992. A reassessment of *Sporidesmium* (*Hyphomycetes*) and some related taxa. Proc. Indian Nat. Sci. Acad. B58: 179-190.

Wu WP, Zhuang W. 2005. *Sporidesmium*, *Endophragmiella* and related genera from China. Fungal Diversity Press, Hong Kong, PRC. 351 pp.

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Type studies in the genus *Crepidotus*

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Abstract — Type collections of six *Crepidotus* species described from Chile, Sri Lanka, and the USA were studied. Microscopic characters are described for each taxon. Macroscopic features provided in the original diagnoses have been supplemented by the micromorphologic variations noted in each specimen; these comparisons support our conclusion that each of the type specimens shares the same set of features exhibited by a previously described species and thus represents part of its variation. We therefore propose that *Crepidotus brunswickianus* should be synonymised with *C. croceitinctus*; *C. cuneiformis*, *C. cystidiosus* and *C. truncatus* with *C. applanatus*; *C. grummosopilosus* with *C. calolepis*; and *C. maximus* with *C. albescens*. Descriptions, illustrations and discussions are provided.

Key words — *Crepidotaceae*, new synonyms, taxonomy, wood-inhabiting fungi

Introduction

Many recent publications have addressed old *Crepidotus* species descriptions in an effort to uncover taxonomically reliable microscopic characters. Ranges of variability for micromorphological features such as cheilocystidia, pileipellis, trama tissues, and basidiospores have become better known for many taxa. SEM examinations of basidiospores have also revealed important spore ornamentation patterns useful for recognizing lineages in the genus (Bandala & Montoya 2000ab, Bandala et al. 2006, Gonou-Zagou & Delivorias 2005, Horak & Desjardin 2004, Pegler & Young 1972, Senn-Irlet 1995, Senn-Irlet & De Meijer 1998). A number of described *Crepidotus* taxa still need additional documentation of anatomical patterns (especially microscopical) to place them within the current taxonomic system of the genus. The morphological patterns of variation reported for some taxa seem, however, to be associated more with morphologic plasticity among individual specimens than with taxonomically significant support for species isolation. In this paper we compare *C. albescens*, *C. applanatus*, *C. calolepis*, and *C. croceitinctus* with six type specimens and eight collections from Chile, the USA and Sri Lanka (Ceylon) . Reexamination revealed that the extremes of some macro- and microscopic features overlap within the range of the morphological variation reported by one or another of these species. From this we conclude that the six types examined do not represent discrete taxonomic entities but rather should be assigned to a previously described species. Descriptions, illustrations and discussions of each are presented.

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Materials and methods

Hand sections of dried basidiomes were mounted and examined microscopically in 3% KOH or Congo red with all measurements taken in KOH. Basidiospore measurement notations and SEM analytical methodology follow Bandala et al. (1999, 2006) and Bandala & Montoya (2000a, 2004). $\overline{X}$ refers to the length × width of *n* basidiospore mean (for one specimen) or range of means (for more than one specimen); similarly, *Q* corresponds to the mean or range of means of the basidiospore length/width ratio. Herbarium acronyms follow Holmgren et al. (1990).

Taxonomy

Crepidotus brunswickianus (Speg.) Sacc.,
Syll. Fung. 9: 116, 1891. PLATES 1 & 7A-C
Bas.: *Agaricus brunswickianus* Speg., Bol. Acad. Nac. Cien. Córdoba 11: 13, 1887.

HOLOTYPE: CHILE. TIERRA DE FUEGO: Voces Bay, May 1882, *C. Spegazzini 17022* (LPS, Spegazzini Fungi Patagonici No. 19).

OTHER MATERIAL STUDIED — ARGENTINA. NEHUEQUÉN: Quetrihué, 15.V.1952, *R. Singer M 641*. Puerto Manzano, 18.V.1952, *R. Singer M 736* (both at LIL); 9.IV. 1963, *R. Singer 3365* (MICH). VENEZUELA. MERIDA: S of Santo Domingo, Laguna Negra and Laguna de Los Palos, 31.VII.1958, *R.W.G. Dennis 1760* (K) (all as *C. brunswickianus*).

Macroscopic description provided by Spegazzini (1887):

> *"... PILEUS dimidiatus... -3 × 1.5 in. ... antice rotundatus, postice subreniformis v. cuneatus, in STIPITE brevissimo, albo, dense irregulariterque papilato-tomentosulo, crassiusculo productus, margine integro, incurvo donatus, glaber, laevissimus, pallide melleus v. fulvo-lutescens, sub iove pluvio hygrophanus; LAMELLAE pileo concolores confertiusculae, polimacriae, antice rotundato-acutatae, postice attenuato-decurrentes, non confluentes, acie integerrimae..."*

Microscopic features recovered from the holotype:

BASIDIOSPORES 7–8.5 (–9.5) × (4.5–) 5–6.5 (–7) µm, $\overline{X}$= 7.6 × 5.7 µm, *Q* = 1.30, broadly ellipsoid, at times rather subglobose, suprahilar depression not or weakly developed, verrucose to moderately coarsely verrucose, ochraceous to yellowish-brown, ornamentation darker, then orangish-brown in mass, thick-

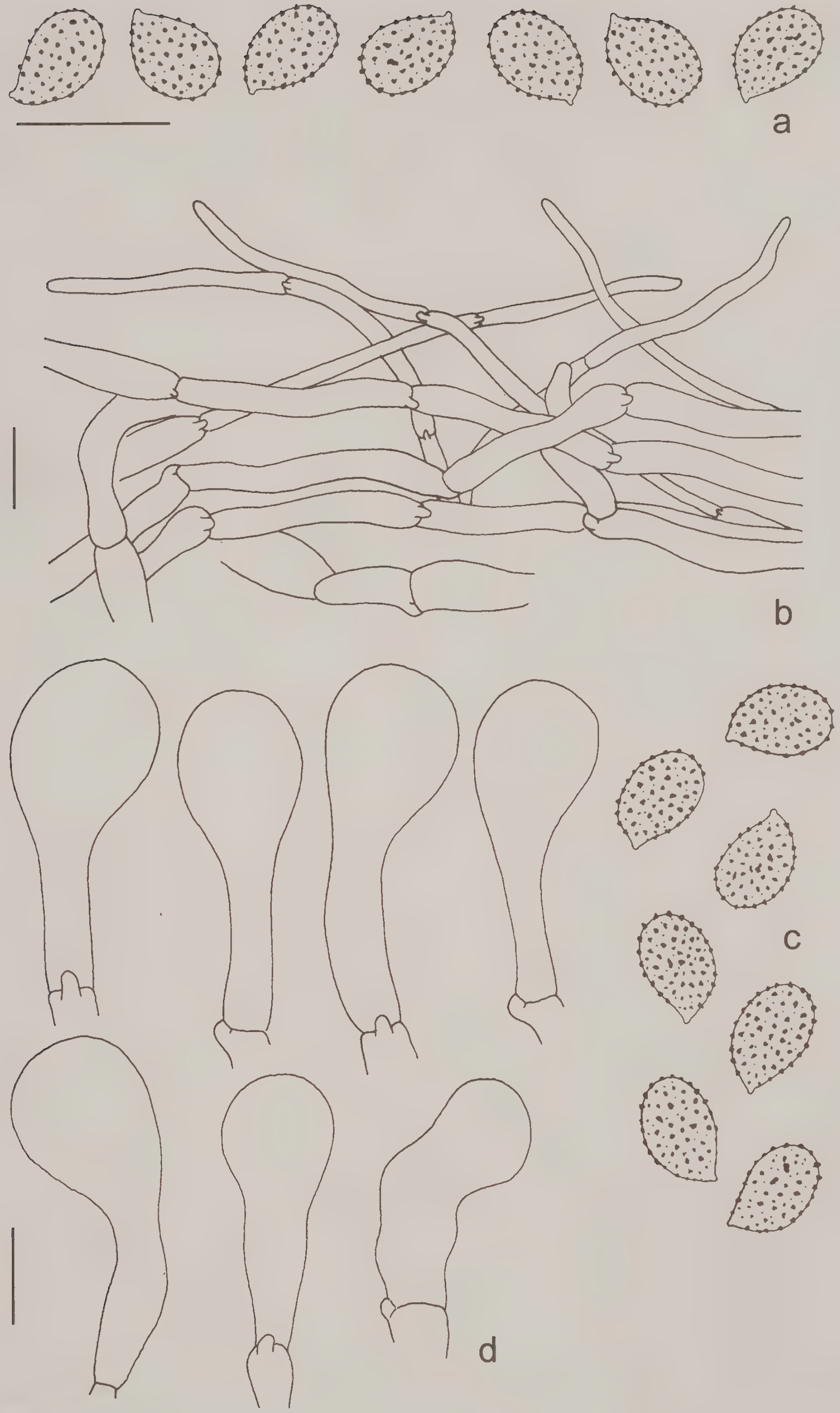

Plate 1. *Crepidotus croceitinctus*. a. Basidiospores (Spegazzini 17022, holotype of *Agaricus brunswickianus*). b. Pileipellis. c. Basidiospores. d. Cheilocystidia (Singer 3365). Scale bar = 10 µm, except b = 15 µm.

walled (≤ 0.5µm wide); under SEM the ornamentation consists of distinctive rounded or more or less truncate, hemispheric to conical (occasionally somewhat rod-like), isolate verrucae, at times two or more verrucae are joined appearing irregular in shape or forming short bulges. Tissues hardly revived with KOH but TRAMA of both PILEUS and HYMENOPHORE consists of non-gelatinized, hyaline, clamped hyphae. BASIDIA, CHEILOCYSTIDIA and PILEIPELLIS not recovered.

COMMENTS — The type consists of incomplete basidiome fragments in such poor condition that some characters appear to be missing completely. As Singer (1947, 1953) also noted, only basidiospore and some tissue characters could be recovered from Spegazzini's specimen. The holotype basidiospores recall the group of taxa close to *C. palmarum* Singer and *C. croceitinctus* in *Crepidotus* section *Sphaerula* Hesler & A.H. Sm. (sensu Senn-Irlet 1995, Senn-Irlet & De Meijer 1998). The basidiospore data, combined with the macroscopic features described by Spegazzini (1887), suggest that *C. brunswickianus* is conspecific with *C. croceitinctus,* a species characterized by basidiomes that are distinctly yellow (or yellowish to orange), possess broadly ellipsoid, verrucose basidiospores, clavate or irregularly (due to outgrowths) clavate cheilocystidia, and a pileipellis that is basically a cutis (Bandala & Montoya 2000b, Pereira 1990, Senn-Irlet & De Meijer 1998, Singer 1973). Specimens from Argentina and Venezuela possessing similar microcharacters as *C. croceitinctus* and originally referred by Dennis (1961) and Singer (1973) to *C. brunswickianus* have basidiospores and cheilocystidia measuring 5.5–9(–9.5) × 4.5–7.5(–8) µm ($\overline{X}$ = 6.5–8.4 × 5.2–6.9 µm, Q = 1.20–1.40) and (25–)28–55 × 4–10(–13) × (apex) 8–17(–19) µm respectively (Plate 1b-d). SEM micrographs (Plate 7a-c) reveal that the basidiospores of all samples show the shape and ornamentation that are distinctive of *C. croceitinctus*. The similarity in microcharacters and the fact that both Dennis and Singer described their specimens as having yellow pilei support our hypothesis that the South American collections represent a variation of *C. croceitinctus*. Illustrations in Horak (1964) and data in Lazo (1971) "… chapeau… jaune orange… Lames oranges… spores 7–8.3 × 5 µm, spinuleuses… cheilocystidia 25–30 × 6–9.5 µm, claviformes, versiformes…" also support this conclusion. Therefore, we assign the holotype of *C. brunswickianus* to *C. croceitinctus* and propose the following synonymy:

Crepidotus croceitinctus Peck, Ann. Rep. N.Y. Stat. Mus. 39: 72, 1886.
Syn.: *Agaricus brunswickianus* Speg., Bol. Acad. Nac. Cien. Córdoba 11: 113, 1887.
≡ *Crepidotus brunswickianus* (Speg.) Sacc., Syll. Fung. 9: 116, 1891.

Singer & Digilio (1951) and Horak (1979) appear to have referred collections characterized by ellipsoid basidiospores and cylindric to +/- narrowly lageniform cheilocystidia to *C. brunswickianus.* These could be better referred to *C. luteolus* (Lambotte) Sacc. or *C. icterinus* Singer (cf. descriptions in Senn-Irlet 1995, Singer 1973).

Crepidotus cuneiformis Pat.,
Bull. Soc. Mycol. France 18: 173, 1902. PLATES 2A, 3A & 7D

HOLOTYPE: **GUADALOUPE**. Bois des Basses Terres, no date, *P. Duss 31* (FH, Patouillard Herbarium No. 405).

Macroscopic description provided by Patouillard (1902):

> *"... CHAPEAU convexe-plan, incurve en avant, striolé sur les bords, atténué en coin en arrière, CHARNU, mou, glabre, brun pâle, large de 8-12 millim. LAMES larges, inégales, brunnàtres, peu serrées, molles, se prolongeant jusqu'au point d'insertion..."*

Microscopic features recovered from the holotype:

BASIDIOSPORES 5.5–7 × 5.5–6.5 (–7) µm, $\bar{X} = 6.1 \times 5.9$ µm, $Q = 1.03$, globose to subglobose, some somewhat cuneate towards the apiculus, finely and densely spinulose to spinulose-verruculose seen under light microscope, baculate when observed under SEM, i.e. with more or less homogeneous, short or moderately long, rod-like or conical protuberances which are apically truncate, small verrucae can be also present among the bacules; thick-walled (≤ 0.5 µm thick), yellowish to yellowish-brown. BASIDIA and elements of hymenium collapsed and not recovered. CHEILOCYSTIDIA not observed, lamellae edges collapsed and hardly revived with KOH. PILEIPELLIS very collapsed, but apparently a cutis composed of hyaline (occasionally pale yellowish hyphae are intermixed), thin-walled, cylindric hyphae, 5–10 µm diam., with undifferentiated terminal elements; in some segments the hyphae at times show a kind of incrusted, colorless, residual material. PILEUS TRAMA with hyaline, cylindric to subventricose, thin-walled hyphae 5–20 (–30) µm diam., some oleiferous-like hyphae (yellowish) present. HYMENOPHORAL TRAMA subregular to subirregular, composed of cylindric to subventricose, thin-walled, hyaline hyphae, with some barely punctate segments. CLAMP CONNECTIONS present in all tissues.

COMMENTS— Macroscopically, elements of the type collection recall small forms of *C. applanatus*. The shape, texture, and color of pileus recorded by Patouillard (1902) fit well within the range of variability of this species. Although Hesler & Smith (1965) also noted the collapsed lamellae edges in the holotype, they observed few clavate cheilocystidia. Pegler (1983) reported clavate to ventricose or ampullaceous cheilocystidia in Patouillard's specimen. The cheilocystidia in combination with the globose, baculate (seen under SEM) basidiospores and pileipellis cutis bearing colorless hyphae, support considering the Duss 31 specimen as conspecific with *C. applanatus*. The "...brun pâle..." pileus of *C. cuneiformis*, apparently the primary character used by Hesler & Smith (1965) to separate it from the *C. applanatus* group is here regarded more as an intermediate form of *C. applanatus* than representing an independent species. Previously Singer (1947) referred the Duss 31 specimen to *C. aquosus* Murrill, which, however, is distinguished from *C. applanatus* by long, narrowly sublageniform cheilocystidia (Singer 1973, Senn-Irlet & De Meijer 1998). The

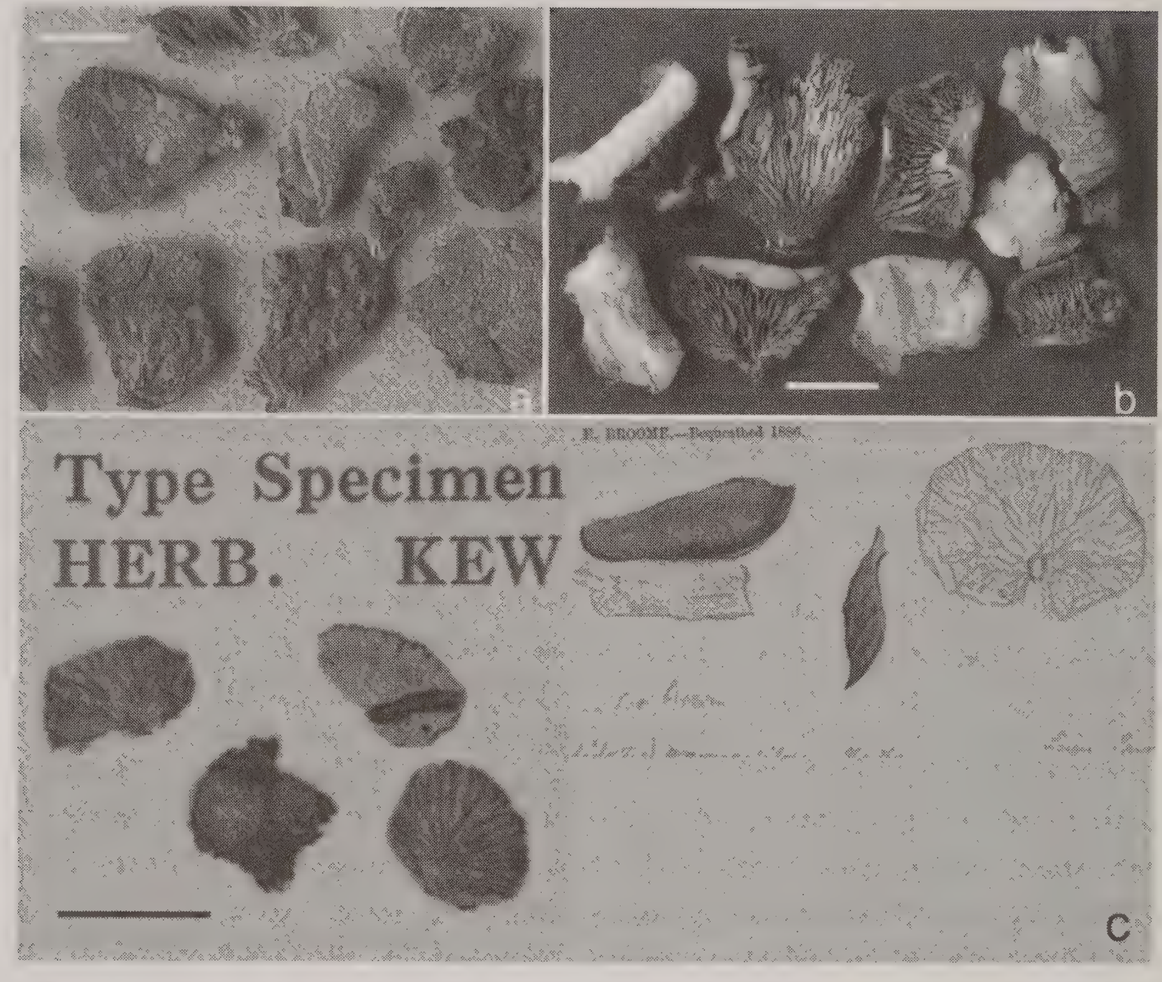

Plate 2. a-b: *Crepidotus applanatus* (a. Duss 31, holotype of *C. cuneiformis*. b. Smith 66854, holotype of *C. cystidiosus*). c. *Crepidotus calolepis* (Thwaites 954a, lectotype of *C. grumosopilosus*).
Scale bar = 10 mm, except a = 5 mm.

specimen from Mexico that Singer (1973) referred to *C. cuneiformis* (Singer M 8038, F) differs from the holotype and represents instead *C. palmarum* (Bandala & Montoya 2004). Since the Duss 31 specimen macro- and microscopically falls within the range of variation reported for *C. applanatus*, we propose the following synonymy:

Crepidotus applanatus (Pers.) P. Kumm., Führ. Pilzk. p. 74, 1871.
Bas.: *Agaricus applanatus* Pers., Obs. Mycol. 1: 8, 1796.
Syn.: *Crepidotus cuneiformis* Pat., Bull. Soc. Mycol. France 18: 173, 1902.

Crepidotus cystidiosus Hesler & A.H. Sm.,
N. Am. Sp. *Crepidotus*, p. 43, 1965. PLATES 2B, 3B-E & 7E-F

HOLOTYPE: USA. MICHIGAN: Colonial Point Hardwoods, 22.VII.1963, *A.H. Smith 66854* (MICH).

OTHER MATERIAL STUDIED— MEXICO. OAXACA: San Agustin, 10.VII.1969, *R. Singer M 8413* (F). USA. MICHIGAN: Cheboygan Co., Maple River, Univ. Michigan Biol. Stat., 24.VI.1956, *H.D. Thiers 2668* (MICH) (both as *C. cystidiosus*).

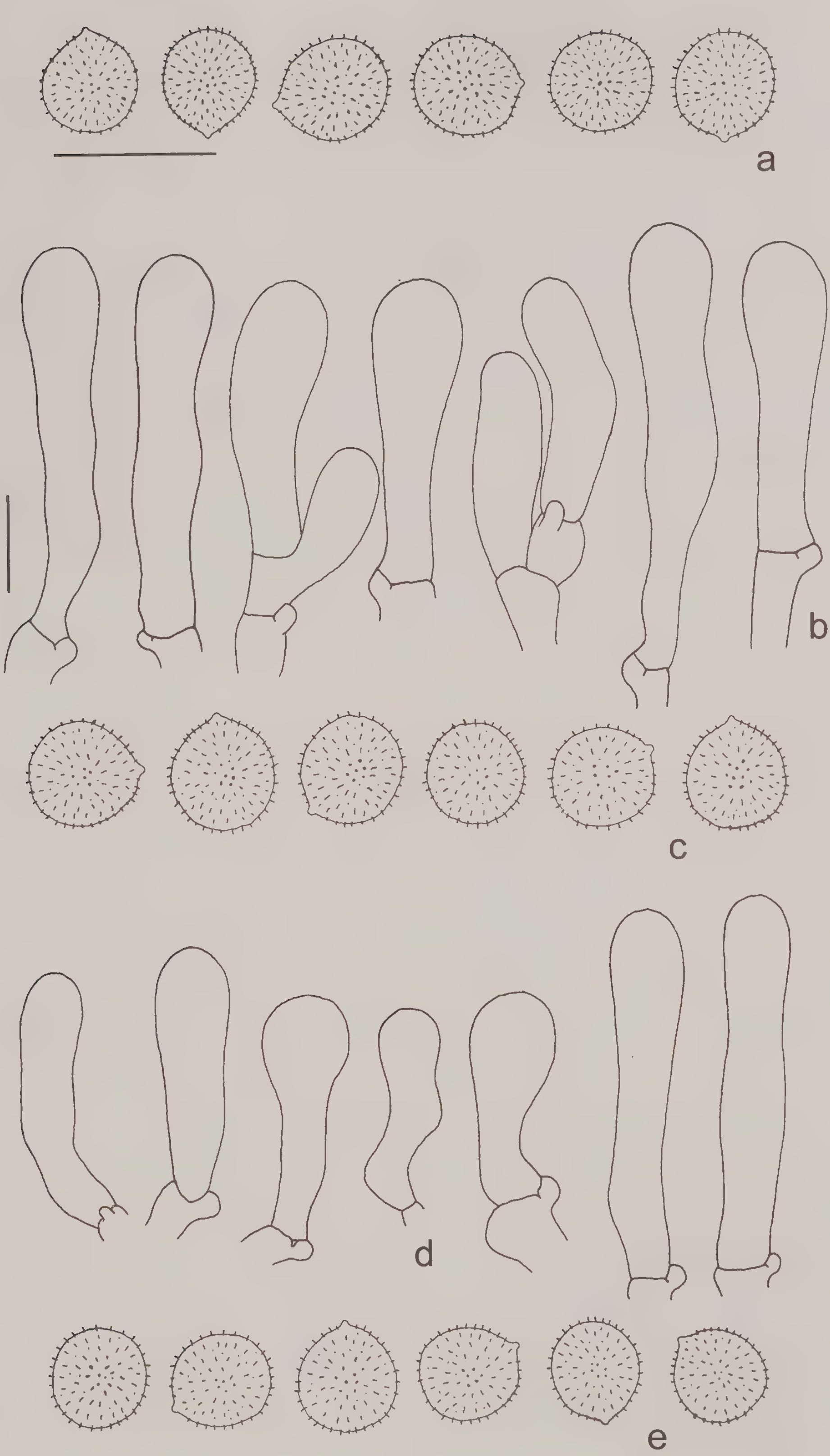

Plate 3. *Crepidotus applanatus*. a. Basidiospores (Duss 31, holotype of *C. cuneiformis*). b. Cheilocystidia. c. Basidiospores (Smith 66854, holotype of *C. cystidiosus*). d. Cheilocystidia e. Basidiospores (Singer M 8413). Scale bar = 10 μm.

Macroscopic description provided by Hesler & Smith (1965):

> "... PILEUS 1.5–6 cm broad, sessile, white or pallid, hygrophanous, becoming alutaceous to buff in age, spathulate, dimidiate, or reniform, glabrous or slightly tomentose, margin striate when moist. CONTEXT thin, white, soft; odor mild, taste fungoid or mild, soon becoming somewhat bitter-astringent. LAMELLAE close, medium broad, white, becoming dull clay color, edges fimbriate..."

Microscopic features recovered from the holotype:

BASIDIOSPORES 5–6.5 (–7) × 5–6.5 (–7) µm, $\overline{X} = 6.0 \times 5.8$ µm, $Q = 1.02$, globose to subglobose, spinulose to spinulose-verruculose seen under light microscope, baculate when observed under SEM, i.e. with more or less homogeneous, conical or rod-like, apically truncate protuberances, also small verrucae can be present among the bacules; thick-walled (≤ 0.5 µm thick), yellowish to yellowish-brown. BASIDIA (20–) 22–28 (–30) × 6–8 (–10) µm, clavate, tetrasporic, at times mono- or bisporic, hyaline, clamped. PLEUROCYSTIDIA absent; sterile bodies resembling amorphous basidia or anomalous basidioles occasionally present, inconspicuous. CHEILOCYSTIDIA 23–40 × 5–7 µm, numerous, clavate, narrowly clavate or subclavate, often more or less narrowly utriform, somewhat flexuous, apex 6–9 µm broad, rounded, at times subcapitate, hyaline, thin-walled, clamped. PILEIPELLIS a cutis composed of more or less compactely arranged, hyaline, thin-walled, cylindric or somewhat ventricose hyphae 5–15 µm diam., occasionally some segments pale yellowish; terminal elements scarce, undifferentiated or at times more or less narrowly lageniform. PILEUS TRAMA with hyaline, cylindric to subventricose, thin-walled hyphae, 4–15 (–20) µm diam., some oleiferous-like hyphae (yellowish) present. HYMENOPHORAL TRAMA subregular, with cylindric to subventricose, thin-walled, hyaline hyphae, 4–15 µm diam., some oleiferous-like hyphae (yellowish) present. CLAMP CONNECTIONS present in all tissues.

COMMENTS— Except for the so-called pleurocystidia described by Hesler & Smith (1965), the type specimen of *Crepidotus cystidiosus* is identical to *C. applanatus*. Macro- and microscopically, A.H. Smith 66854 shows all the characters of *C. applanatus*, i.e. size, shape and color of pileus, globose, spinulose basidiospores that bear a baculate ornamentation pattern when observed under SEM, clamped hyphae, and a pileipellis cutis lacking brown incrusted pigments (cf. descriptions in Josserand 1937, Senn-Irlet 1995, Gonou-Zagou & Delivorias 2005). Analysis of tangential sections reveals that the hymenial elements on the lamellar face are more or less homogeneous with regard to size and shape (clavate, narrowly clavate or subcylindric). Occasional sterile bodies, apparently the so-called pleurocystidia, were detected (if somewhat ambiguously recognized) among the hymenial elements. Such structures, which possibly represent abnormal basidia or basidioles, can hardly be interpreted as true cystidia and do not support recognition of A.H. Smith 66854 as an independent taxon. Other materials from Oaxaca and Michigan identified as *C. cystidiosus* by Singer (1973) and Hesler & Smith (1965) also do not show clear evidence of sterile bodies that can be reliably interpreted as pleurocystidia. The unpredictable occurrence of such structures, similarly observed by other authors in different samples of *Crepidotus*, reduces their value for taxonomic purposes (Bandala & Montoya 2000a, Gonou-Zagou & Delivorias 2005, Senn-Irlet 1995, Senn-Irlet & De Meijer 1998, Singer 1973). The macro- and microscopic features exhibited by the holotype support placing this taxon in synonymy with *C. applanatus* as follows:

Crepidotus applanatus (Pers.) P. Kumm., Führ. Pilzk. p. 74, 1871.
Bas.: *Agaricus applanatus* Pers., Obs. Mycol. 1: 8, 1796.
Syn.: *Crepidotus cystidiosus* Hesler & A.H. Sm., N. Am. Sp. *Crepidotus*, p. 43, 1965.

Crepidotus grumosopilosus (Berk. & Broome) Sacc.,
Syll. Fung. 5: 884, 1887. PLATES 2C, 4A-C & 7G-H
Bas.: *Agaricus grumosopilosus* Berk. & Broome, J. Linn. Soc. Bot. 11: 546, 1871.

LECTOTYPE: SRI LANKA (CEYLON). Peradeniya, January 1896, *Thwaites 954a* (K) (selected by Pilát 1950).

Macroscopic description by Berkeley & Broome (1871) for the specimen no. 954a, cum icone, on dead wood. Jan. 1869:

> "... PILEUS suborbicular or reniform, rarely flabelliform, at first resupinate, then reflexed, white, striate, at first marked with radiating matted hairs which gradually acquire a more or less ferruginous tint and form scattered spots; STEM very short or quite obsolete; GILLS 2 lines or more broad, ventricose, pale ferruginous... "

Microscopic features recovered from the lectotype:

BASIDIOSPORES (7–) 8–10 × (5–) 5.5–7 µm, $\bar{X}$ = 9.0 × 6.4 µm, *Q* = 1.40, ellipsoid, some more or less amygdaliform in side view, smooth (even under SEM), thick-walled (≤ 0.5 µm thick), yellowish-brown. BASIDIA 17–25 (–30) × (8–) 9–10 µm, clavate to subcylindric, tetrasporic, hyaline, thin-walled. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA 23–60 × 4–9 (–11) µm, numerous, narrowly utriform to narrowly sublageniform, occasionally subcylindric to narrowly clavate or subclavate, apex rounded 3–9 µm wide, occasionally subfusiform, somewhat flexuous, embedded in gelatinous material, hyaline, clampless. PILEIPELLIS a compactly arranged, interrupted cutis, composed of cylindric to subventricose, yellowish to yellowish-brown hyphae 5–15 (–20) µm wide, thin- or thick-walled (< 0.5 µm thick), with incrusting pigment, at times the incrustations producing discontinuous lines, occasionally some hyaline hyphae are intermixed; terminal hyphae undifferentiated or somewhat attenuated, prostrated or semierect. PILEUS TRAMA consisting of hyaline, cylindric to subventricose or short-bifurcate, thin-walled hyphae 3–20 µm wide, some recalling puzzle-like elements, forming a compactly arranged, gelatinized tissue, without any distinctively refringent layer in tangential section. Hymenophoral trama with a mediostratum, subregular, composed of cylindric to subventricose, compactly arranged, hyaline, non-gelatinized hyphae, 3–20 µm wide; laterostrata poorly differentiated, gelatinized, composed of hyaline, thin-walled, filamentous hyphae 3–7 µm wide. Clamp connections absent.

Comments— In his revision of species from Ceylon (Sri Lanka) described by Berkeley & Broome, Petch (1924) pointed out that the type collection of *Agaricus grumosopilosus*, Thwaites 954a cum icone, consisted of a mixture of specimens representing different species. Years later, Pilát (1950) recognized *C. grumosopilosus* as a smooth-spored species, which he lectotypified by selecting three specimens from Thwaites 954a. Pilát identified a fourth specimen bearing ornamented spores within this same collection as *C. truncatus*. Pegler (1986), who later examined Thwaites 954a and also distinguished two separate entities, referred the smooth-spored taxon (separated as Thwaites 954a p.p.) to *C. melleus* (Berk. & Broome) Petch and the taxon with ornamented spores (Thwaites 954a p.p. cum ic.) to *C. grumosopilosus*. There are, however, now in K two collections numbered 954a, **both** labeled as type specimens of *C. grumosopilosus*. [Note: another species also recorded by Berkeley & Broome (1871) as 954 (and 954b) is *C. epicrocinus* (Berk & Broome) Sacc., not discussed here]. One of the K 954a collections is coded "K(M): 49551" and the other is coded "K(M): 42400". Our reexamination of both collections reveals that they are indistinguishable from previously described species, suggesting that *Agaricus grumosopilosus* should be reduced to a synonym. This conclusion, which partly agrees with that of Pilát (1950) but opposes that of Pegler (1986), led us to reevaluate the nomenclatural and taxonomic status of the material kept at K.

Collection 954a [49551], unlike collection 954a [42400], is accompanied by a color drawing of some of its basidiomes (Plate 2c). The herbarium sheet, as noted by both Pilát (1950) and Pegler (1986), accompanies drawings by Berkeley showing smooth, ellipsoid basidiospores. Collection 954a [49551] is thus interpreted as representing the specimens included in the protologue and studied by the aforementioned authors. As collection 954a [49551] contains mixed specimens representing different species, then the macroscopic data in the diagnosis (see above) presumably embraced features of all specimens in this collection. In fact, our study revealed that the pileipellis of all basidiomes consists of pigmented, often incrusted, thick-walled hyphae, which macroscopically constitute brown fibrils or squamules actually observed on the pileus surface (when analyzed under magnification) and mentioned in the original description. Five of seven basidiomes in this collection (Plate 2c) possess smooth spores and two have ornamented spores. As observed by Pilát (1950), these two latter basidiomes represent a taxon with a more or less flabelliform, plane-convex pileus, a non-striate margin and laterally attached to

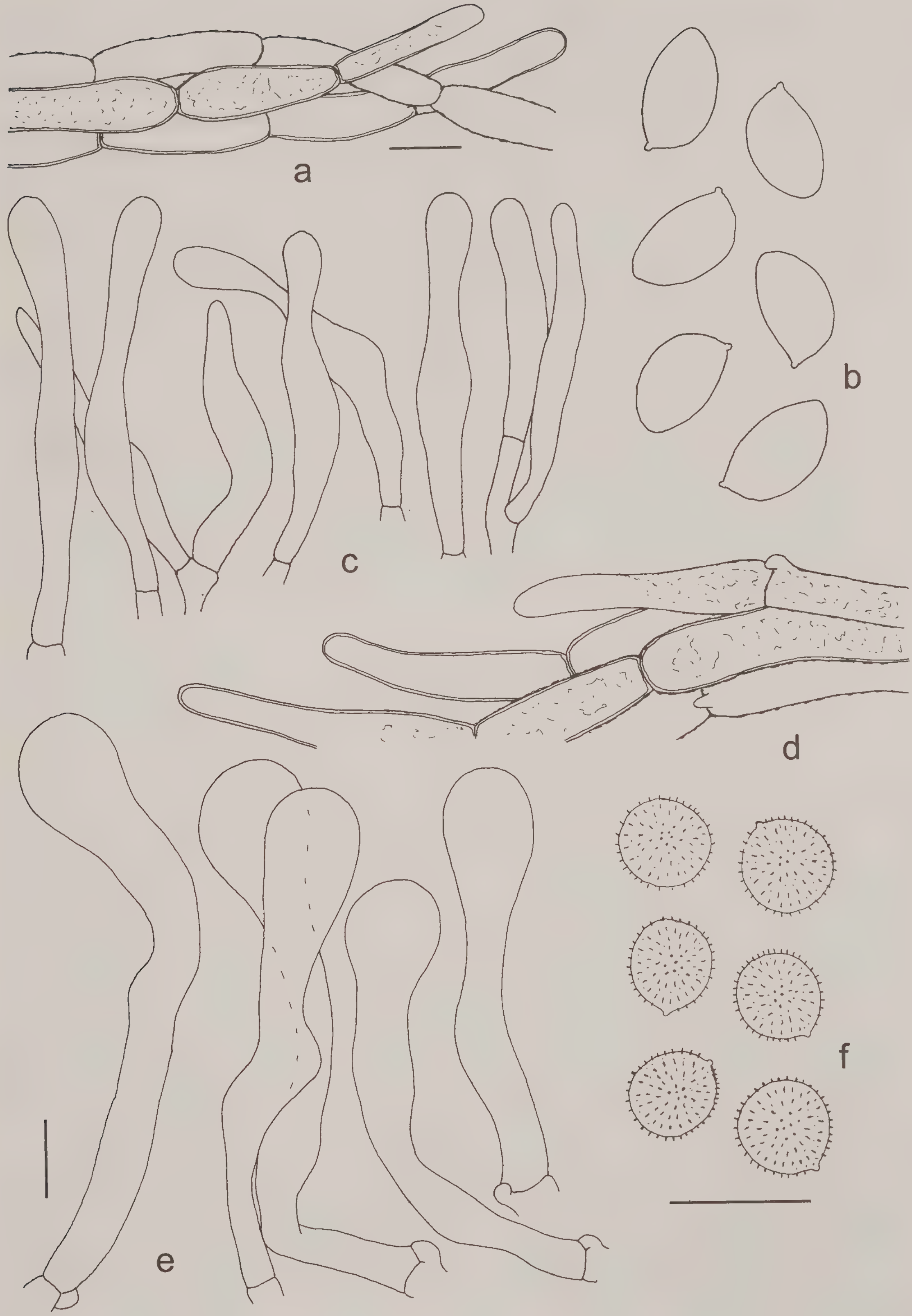

Plate 4. a-c: *Crepidotus calolepis*. a. Pileipellis. b. Basidiospores. c. Cheilocystidia (Thwaites 954a, lectotype of *C. grumosopilosus*). d-f: *Crepidotus crocophyllus*. d. Pileipellis. e. Cheilocystidia. f. Basidiospores (Thwaites 954a.1). Scale bar = 10 µm, except a & d = 15 µm.

the substratum. However, the remaining five smooth-spored basidiomes are distinct even in the dried state due to the subcircular to rounded flabelliform (somewhat reniform when immature, as seen from the hymenophore), convex, striate pileus, with some more or less dorsally attached to substratum reminiscent of an effuse-reflexed pileus. We found among these five basidiomes some that appear with those depicted in Berkeley's color drawing accompanying the collection (Plate 2c). From this, we concluded that these five basidiomes agree better with the protologue (ICBN, Art. 9) than the material selected by Pegler (1986). Pilát's earlier lectotypification (1950) is, therefore, supported.

The microscopic information provided above is based on the aforementioned five basidiomes, which we recognize as representing the lectotype. This material was separated as Thwaites 954a (i.e. Thwaites 954a cum icone) inside the collection K (M): 49551. The set of features exhibited by these specimens, such as smooth spores, gelatinized tissues, clampless hyphae and pileipellis with brown pigmented hyphae (Figs. 4a-c & 7g-h) fall, however, within the range of variation recorded for *C. calolepis*. We interpret, therefore, the specimens as representing this species and for this reason consider *C. grumosopilosus* as a later synonym:

Crepidotus calolepis (Fr.) P. Karst., Bidr. Känn. Finl. Nat. Folk 32: 414, 1879.
Bas.: *Agaricus calolepis* Fr., Öfvers. K. Vetensk.-Akad. Förh. 30: 5, 1873.
Syn.: *Agaricus grumosopilosus* Berk. & Broome, J. Linn. Soc. Bot. 11: 546, 1871.
≡ *Crepidotus grumosopilosus* (Berk. & Broome) Sacc., Syll. Fung. 5: 884, 1887.

The two specimens with ornamented spores, i.e. *C. grumosopilosus* sensu Pegler or *C. truncatus* as identified by Pilát (cf. the type study of this latter below), are indistinguishable from *C. crocophyllus*. These two materials exhibit the following remarkable set of characters (Figs. 4d-f & 7i): basidiospores (5.5–)6–7.5 × (5.5–)6–7(–7.5) µm, $\overline{X} = 6.7 \times 6.5$ µm, $Q = 1.03$, globose, spinulose (baculate under SEM), clamped hyphae, variably clavate or subutriform cheilocystidia (45–) 50–90 (–95) × 5–9 (–10) × (apex) 10–18 (–20) µm, and pileipellis with brown pigmented, often incrusted, thick-walled hyphae, (6–) 9–15 µm wide. We separated these two specimens as Thwaites 954a.1 inside collection K(M): 49551. On the other hand, collection Thwaites 954a K(M): 42400 consists of a single basidiome that has the same features cited above for *C. calolepis*. The herbarium sheet is also accompanied by Berkeley drawings showing smooth, ellipsoid basidiospores; macroscopically, the presence of brown fibrils on the pileus surface (seen under magnification) is remarkable. Relevant microscopic features of this specimen are:

Basidiospores (7.5–)8–10(–10.5) × 5.5–7(–7.5) µm, $\overline{X} = 8.9 \times 6.4$ µm, $Q = 1.40$, ellipsoid, smooth. Cheilocystidia hyaline, clampless, more or less narrowly sublageniform, gelatinized (the lamellar edge is collapsed and could barely be revived in KOH). Pileipellis a cutis composed of cylindric to subventricose, yellowish-brown hyphae, 5–10 µm wide, with or without incrusting pigment. PILEUS TRAMA and HYMENOPHORAL TRAMA with gelatinized hyphae. CLAMP CONNECTIONS absent. It is not clear whether this latter material together with the lectotype were originally a single sample gathered by Thwaites.

Crepidotus maximus Hesler & A.H. Sm.,
N. Am. Sp. *Crepidotus*, p. 100, 1965. PLATES 5 & 7J-K

HOLOTYPE: USA. TENNESSEE: Ball Camp Pike, 7.XI.1936, *R.L. Hesler and S.A. Cain 9718* (TENN).

Macroscopic description provided by Hesler & Smith (1965):

> "...PILEUS 4–13 cm broad, sessile, somewhat imbricate, dimidiate, cuneate or broadly flabelliform, convex, then more or less plane, or the margin wavy and the midportion more or less depressed, white or whitish, becoming tinted "light ochraceous-buff", coarsely rivulose-reticulated, innately fibrillose, distinctly viscid or almost glutinous when wet, soon dry, not hygrophanous, margin incurved and even. CONTEXT thick, tough, rather turgid, pallid. LAMELLAE radiating, white at first, becoming "snuff brown", "argus brown" or "Brussel's brown", with a purple-brown tint where bruised, close, linear, relatively narrow (up to 5 mm), narrowed at the ends, edges white-fimbriate, at times gelatinous..."

Microscopic features recovered from the holotype:

BASIDIOSPORES (6–)6.5–8 × 3.5–4.5(–5) µm, $\overline{X}$ = 7.2 × 4.1 µm, *Q* = 1.76, ellipsoid to more or less narrowly amygdaliform, somewhat depressed adaxially and then more or less narrowly reniform, weakly attenuated towards the apex but rounded, smooth (even under SEM), thick-walled (<0.5 µm wide), yellowish to yellowish-brown. BASIDIA 20–28 × 4–7 µm, tetrasporic, occasionally bi- or monosporic, clavate, thin-walled, hyaline, clamped. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA (62–)73–121(–126) × (3–)4–5 µm, numerous, subcylindric, more or less elongate-subclavate or slightly broadened downwards and then elongate and more or less narrowly lageniform, apex rounded, (4–)5–8(–9) µm wide, neck occasionally bifurcate, often somewhat sinuous towards the base, prominently projected above the hymenium level, hyaline, thin- or slightly thick-walled (<0.5 µm thick), clamped, slightly gelatinized producing a more or less dense, refringent layer on lamellae edge. PILEIPELLIS a broad (± 300–450 µm thick) not gelatinized layer of somewhat loosely interwoven or entangled, more or less filamentous hyphae, 3–5 µm wide, forming a cutis or a transition between a loose cutis and a loose trichoderm, with a variable number of undifferentiated, repent or often erect terminal elements; most hyphae hyaline (some of their segments occasionally pale yellowish), moderately sinuous, often curved, at times bifurcate or with short, lateral outgrowths, clamped, thin- or slightly thick-walled (≤ 0.5 µm thick), smooth or at times some segments weakly punctuate (colorless). PILEUS TRAMA (in tangential section) differentiated in

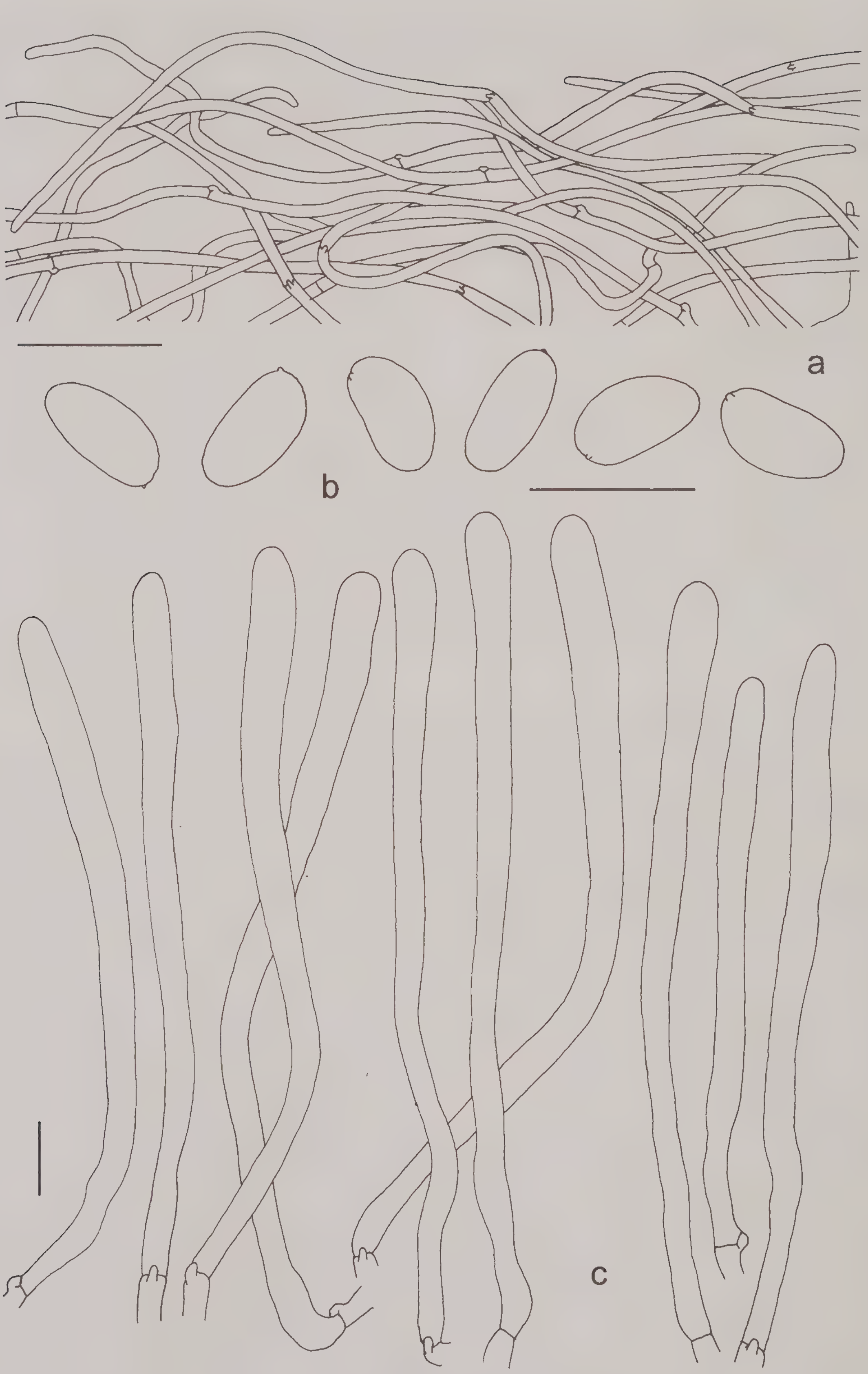

Plate 5. *Crepidotus albescens*. a. Pileipellis. b. Basidiospores.
c. Cheilocystidia (Hesler & Cain 9718, holotype of *C. maximus*).
Scale bar = 10 µm, except a = 20 µm.

two layers, one beneath pileipellis, gelatinized, refringent, variable in thickness (± 200–400 µm thick), composed of more or less filamentous hyphae (1–) 2–4 µm wide, hyaline or at times with some segments with a dense, yellowish content, thin-walled, smooth or occasionally obscurely punctuate (colorless), flexuous, more or less radially oriented and loosely interwoven; below that layer is a distinctive, moderately compact, gelatinized but not refringent stratum comprising most of the pileus context and composed of colorless, thin-walled, subcylindric to subventricose, simple or bifurcate hyphae, 5–15 (–20) µm wide. HYMENOPHORAL TRAMA with a mediostratum, subregular, composed of cylindric to subventricose, compactly arranged, hyaline, not gelatinized hyphae, 4–15 µm wide; laterostrata refringent, gelatinized, composed of filamentous, colorless to pale yellowish, thin-walled hyphae, 2–4 (–5) µm wide, loosely and more or less divergently arranged. CLAMP CONNECTIONS present in all tissues.

COMMENTS— Microscopically Hesler & Cain 9718 exhibits all the distinctive characters of *C. albescens* that include the moderately reniform, smooth basidiospores, elongate cheilocystidia, clamped hyphae, entangled cutis and gelatinized tissues (Hesler & Smith (1965) under *C. phaseoliformis* Hesler & A.H. Sm., Redhead 1984, pers. obs.). The pileus size and the color change of gills when bruised (i.e. with a purple-brown tint) were the main features Hesler & Smith (1965) used to separate *C. maximus* from *C. betulae* Murrill, the latter equated with *C. albescens* after type study (we shall discuss *C. albescens* and related species in a separate paper). Certainly the type specimen supporting *C. maximus* possesses a somewhat large pileus, but it perhaps corresponds to the upper limit of pileus size in *C. albescens*. Microscopically, the fine fibrillose pileus covering forms a dense hyphal layer that is slightly thicker than that observed in other collections. The pileus size, the apparent color change of lamellae, and even the thickness of the pileipellis layer showed by Hesler & Cain 9718 seem to fall within the range of variability to be expected for a single taxon rather than indicate a taxonomic separation. The color change of the lamellae needs more observation before it can be considered discriminative. Since macro- and microscopically the holotype falls within the range of variation of *C. albescens*, we consider that *C. maximus* is not an independent taxon:

Crepidotus albescens (Murrill) Redhead, Sydowia 37: 255, 1984.
Bas.: *Geopetalum albescens* Murrill, N. Am. Fl. 9: 299, 1916.
Syn.: *Crepidotus maximus* Hesler & A.H. Sm., N. Am. Sp. *Crepidotus*, p. 100, 1965.

Crepidotus truncatus Petch, Ann. Roy. Bot. Gard. Perad. 9: 226, 1924. PLATES 6-7L

HOLOTYPE: SRI LANKA (CEYLON). CENTRAL PROVINCE: Kandy District, Peradeniya, 19.XII.1914, *T. Petch 4384* (K).

OTHER MATERIAL STUDIED— MEXICO. CHIAPAS: along road from Finca Suspiro to El Pozo, 4.VIII.1969, *R. Singer M 8965* (F, as *C. truncatus*).

Macroscopic description provided by Petch (1924):

> "... PILEUS elliptical, lobed behind, broadly convex, 4 × 2.5 cm., pallid, covered with a thin layer of matted fibrils, strongly tomentose and white at the point of attachment, striate from the margin over half the pileus when moist; GILLS not crowded, very broad (up to 1 cm.), ventricose, pallid then brownish, truncate behind, terminating at an excentric, white, tomentose area under the point of attachment...".

Microscopic features recovered from the holotype:

BASIDIOSPORES 5.5–6.5 × 5.5–6.5 µm, $\overline{X}$ = 6.2 × 6.1 µm, Q = 1.02, globose, spinulose to spinulose-verruculose (under light microscope), baculate under SEM, i.e. with conical or rod-like, apically truncate protuberances, small verrucae can be present among the bacules; thick-walled (≤ 0.5 µm thick), yellowish-brown. BASIDIA clavate, tetrasporic, hyaline, clamped. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA hardly revived with KOH, the lamellae edge is somewhat collapsed but some clavate forms were observed (or part of their upper extremes with rounded apex), hyaline, thin-walled, clamped. PILEIPELLIS a cutis composed of hyaline, thin-walled hyphae 2–5(–7) µm wide, occasionally some segments pale yellowish; terminal elements undifferentiated or somewhat narrowly lageniform, at times somewhat erect then recalling a more or less trichodermoid arrangement. PILEUS TRAMA with hyaline to yellowish, cylindric to subventricose, thin-walled hyphae. HYMENOPHORAL TRAMA subregular, with cylindric to subventricose, thin-walled, hyaline hyphae. *Clamp connections* present in all tissues.

COMMENTS — The combination of features exhibited by the holotype, such as the globose, spinulose (baculate under SEM) basidiospores, clavate cheilocystidia, pileipellis cutis with colorless hyphae and clamp connections, indicates that *C. truncatus* is the same as *C. applanatus*. The macroscopic variation described by Petch (1924) also falls within the range of variation reported for *C. applanatus* (Gonou-Zagou & Delivorias 2005, Hesler & Smith 1965, Josserand 1937, Nordstein 1990, Pilát 1948, Senn-Irlet 1995). Singer (1955) found *C. truncatus* similar to either *C. applanatus* or *C. nephrodes* sensu Singer but later (Singer 1973: 369) treated *C. truncatus* as an autonomous species, segregating it from *C. applanatus* based on pileus color: *C. applanatus* with a whitish pileus and a marginal zone tinged argillaceous-gray when fresh, not brownish unless in age when dried and *C. truncatus* with a brown or pale brown pileus (although this detail does not agree with the diagnosis, see above). We have reexamined a collection from Mexico that Singer (1973) identified as *C. truncatus;* Singer M 8965 is likewise morphologically indistinguishable from *C. applanatus,* representing a small form with:

BASIDIOSPORES 5.5–7 × (5–)5.5–6.5 µm, $\overline{X}$ = 6.1 × 5.9 µm, Q = 1.04, globose, baculate (under SEM), and CHEILOCYSTIDIA (15–)20–55 × (3–)4–9

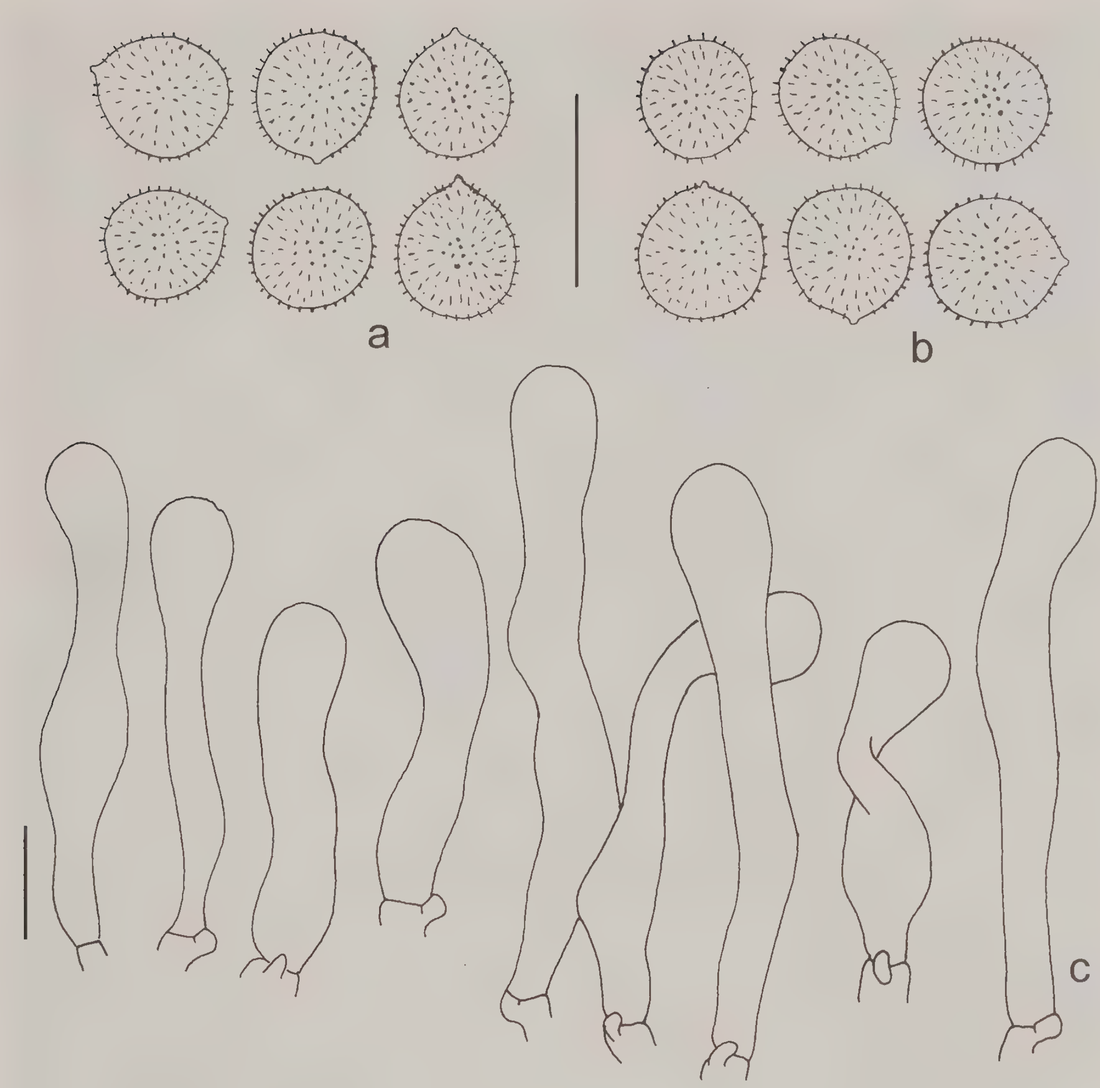

Plate 6. *Crepidotus applanatus*. a. Basidiospores (Petch 4384, holotype of *C. truncatus*). b. Basidiospores. c. Cheilocystidia (Singer 8965). Scale bar = 10 µm.

µm, apex 3–9(–12) µm wide, numerous, clavate, narrowly clavate or more or less narrowly utriform, hyaline thin-walled, clamped (Plate 6b-c).

From the above, we concluded that the Sri Lankan type collection of *C. truncatus* represents *C. applanatus* and is a later synonym:

Crepidotus applanatus (Pers.) P. Kumm., Führ. Pilzk. p. 74, 1871.
Bas.: *Agaricus applanatus* Pers., Obs. Mycol. 1: 8, 1796.
Syn.: *Crepidotus truncatus* Petch, Ann. Roy. Bot. Gard. Perad. 9: 226, 1924.

As noted in the earlier discussion on *C. grumosopilosus*, Pegler (1986) considered *C. truncatus* and *C. grumosopilosus* to be conspecific. We shall discuss the taxonomy of *Agaricus nephrodes* Berk. & M.A. Curtis, which Pegler (1977) considered synonymous to *Crepidotus truncatus*, in a separate paper devoted to the species related to *C. crocophyllus* (cf. also Ripková et al. 2005).

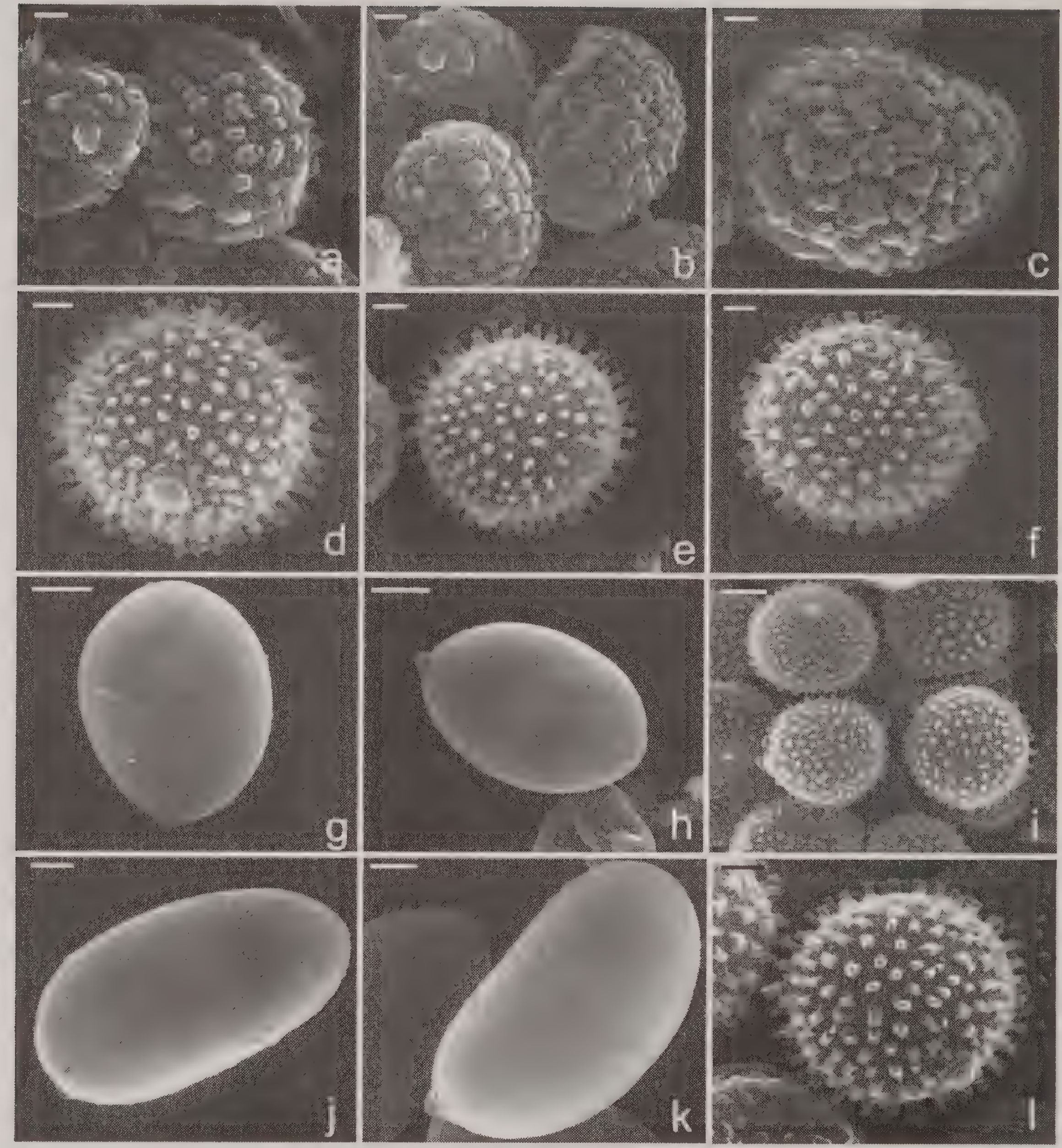

Plate 7. a-c: *Crepidotus croceitinctus* (a. Spegazzini 17022, holotype of *C. brunswickianus*. b. Singer 3365. c. Dennis 1760). d-f: *Crepidotus applanatus* (d. Duss 31, holotype of *C. cuneiformis*. e. Smith 66854, holotype of *C. cystidiosus*. f. Singer M 8413). g-h: *Crepidotus calolepis* (Thwaites 954a, lectotype of *C. grumosopilosus*). i: *Crepidotus crocophyllus* (Thwaites 954a.1). j-k: *Crepidotus albescens* (Hesler & Cain 9718, holotype of *C. maximus*). l. *Crepidotus applanatus* (Petch 4384, holotype of *C. truncatus*). Scale bar = 1 μm, except g-i = 2 μm.

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Literature cited

Bandala VM, Montoya L. 2000a. A taxonomic revision of some American *Crepidotus*. Mycologia 92: 341-353.

Bandala VM, Montoya L. 2000b. A revision of some *Crepidotus* species related to Mexican taxa. Mycological Research 104: 495-506.

Bandala VM, Montoya L. 2004. *Crepidotus* from Mexico: new records and type studies. Mycotaxon 89: 1-31.

Bandala VM, Montoya L, Moreno G. 1999. Two *Crepidotus* from Mexico with notes on selected type collections. Mycotaxon 72: 403-416.

Bandala VM, Montoya L, Horak E. 2006. *Crepidotus rubrovinosus* sp. nov. and *Crepidotus septicoides*, found in the cloud forest of eastern Mexico, with notes on *Crepidotus fusisporus* var. *longicystis*. Mycologia 98: 137-146

Berkeley MJ, Broome CE. 1871. The fungi of Ceylan. Jour. Linn. Soc. Bot. 11: 494-571.

Dennis RWG. 1961. Fungi Venezuelani IV. Agaricales. Kew Bull. 15: 67-156.

Gonou-Zagou Z, Delivorias P. 2005. Studies on *Basidiomycetes* in Greece 1: The genus *Crepidotus*. Mycotaxon 94: 15-42

Hesler LR, Smith AH. 1965. North American species of *Crepidotus*. Hafner Pub., N.Y., 168 pp. + 33 figs.

Holmgren PK, Holmgren NH, Barnett LC (eds.). 1990. Index Herbariorum. Part I. The Herbaria of the World, 8th ed. New York, 693 p.

Horak E. 1964. Fungi Austroamericani XI. Nova Hedwigia 8: 333-346.

Horak E. 1979. *Fungi, Basidiomycetes, Agaricales* y Gasteromycetes Secotioides. Fl. Crip. Tierra del Fuego 11 (6): 1-525.

Horak E, Desjardin DN. 2004. Two remarkable taxa of *Crepidotus* from Bonin Islands (Japan) and New Guinea. In: Cripps CL. ed. Fungi in forest ecosystems, diversity and ecology. New York Bot. Gard., New York.

Josserand M. 1937. Notes critiques sur quelques champignons de la Région Lyonnaise (2a ser.). Bull. Soc. Myc. Fr. 28: 175-230.

Lazo W. 1971. Contribution à l'étude des macromycètes du Chili. Lejeunia 61:1-30.

Nordstein S. 1990. The genus *Crepidotus* (*Basidiomicotyna, Agaricales*) in Norway. Synopsis Fungorum 2: 1-115.

Patouilliard N. 1902. Champignons de la Guadaloupe, recueillis par le R.P. Duss. Bull. Soc. Myc. Fr. 18: 171-186.

Pegler DN. 1977. A preliminary agaric flora of East Africa. Kew Bull. Add. Ser. VI. HMSO, London, 615 p.

Pegler DN. 1983. Agaric Flora of The Lesser Antilles. Kew Bull. Add. Ser. IX. HMSO, London.

Pegler DN. 1986. Agaric Flora of Sri Lanka. Kew Bull. Add. Ser. 12. HMSO, London.

Pegler DN, Young TWK. 1972. Basidiospore form in the British species of *Crepidotus*. Kew Bull. 27: 311-323.

Pereira AB. 1990. O genero *Crepidotus* no Rio Grande do Sul, Brasil. Cad. Pesquisa (Bot.) 2: 65-85.

Petch T. 1924. *Agaricaceae* pleuropodes Zeylanieae. Ann. Roy. Bot. Gard. Perad. 9: 217-227.

Pilát A. 1948. Monographie des espèces européenes du genre *Crepidotus* Fr. In: Pilát A, Kavina K. eds. Atlas des champignons de l'Europe 6. Praha. 84 p., 24 figs.

Pilăt A. 1950. Revision of the types of some extra-European species of the genus *Crepidotus* Fr. Trans. Br. Mycol. Soc. 33: 215-249.

Redhead SA. 1984. Mycological observations, 4-12: on *Kuehneromyces, Stropharia, Marasmius, Mycena, Geopetalum, Omphalopsis, Phaeomarasmius, Naucoria* and *Prunulus*. Sydowia 37: 246-270.

Ripková S, Aime MC, Lizoň P. 2005. *Crepidotus crocophyllus* includes *C. nephrodes*. Mycotaxon 91: 397-403.

Senn-Irlet B. 1995. The genus *Crepidotus* (Fr.) Staude in Europe. Persoonia 16: 1-80.

Senn-Irlet B, De Meijer A. 1998. The genus *Crepidotus* from the state of Paraná, Brazil. Mycotaxon 66: 165-199.

Singer R. 1947. Monograph of the genus *Crepidotus*. Lilloa 13: 59-95.

Singer R. 1953. The agarics of the Argentine sector of Tierra del Fuego and limitrophous regions of The Magallanes area. Sydowia 7: 206-265.

Singer R. 1955. Type studies on *Basidiomycetes,* VIII. Sydowia 9: 367-431.

Singer R. 1973. The genera *Marasmiellus, Crepidotus* and *Simocybe* in the neotropics. Beih. Nova Hedwigia 44: 1–484.

Singer R, Digilio APL. 1951. Pródromo de la flora Argentina. Lilloa 25 : 5-461.

Spegazzini C. 1887. Fungi Patagonici. Bol. Acad. Nac. Cien. Córdoba 11: 5-64.

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Sporopodium isidiatum (*Pilocarpaceae*), new from Papua New Guinea and Sri Lanka, with a key to the world's *Sporopodium* lichen species

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Abstract — The new lichen species *Sporopodium isidiatum* is described from Papua New Guinea and Sri Lanka. A key to all known species of *Sporopodium* is provided, as well as a synoptic table of their secondary chemical compounds.

Key Words — *Ectolechiaceae, Micareaceae*

Introduction

The lichen family *Pilocarpaceae* was reinstated by Vězda (1986) to accommodate mainly foliicolous species in the genera *Byssoloma*, *Fellhanera* and *Byssolecania*. However, Lücking & al. (1994) and Lücking (1999) suggested that the family should be emended to include *Ectolechiaceae*, i.e. taxa with characteristic campylidioid anamorphs centered in the genus *Sporopodium*. A recent molecular phylogenetic analysis, based on Bayesian tree sampling and maximum likelihood analysis of mtSSU sequences (Andersen & Ekman 2005), not only confirmed this view but showed that also *Micareaceae* have to be submerged within *Pilocarpaceae*.

Whereas the phylogenetic relationships of genera within this large and diverse clade remain unclear, inventories of tropical regions continuously yield new and undescribed species, especially in the large genera *Byssoloma* and *Fellhanera*, but also in the smaller genera, such as *Sporopodium*. The latter is distinguished by the following combination of characters (Lücking 1999, Santesson 1952, Sérusiaux 1986, Vězda 1986): finely farinose thallus, sometimes with verrucae; branched and anastomosed paraphyses; usually a single muriform spore per ascus (8 in one species); campylidia hood-like, made of a conidia-producing cavity connected to a tiny platform which seems to be covered under a hood-like lobe; and conidia non-septate, ellipsoid to guttuliform (1-septate, with the distal cell rounded and the proximal one ellipsoid-bacillar in a single species). Photobiont cells are present in the epithecium and the conidiogenous layer in some species.

In his world-wide monograph on foliicolous lichens, Santesson (1952) recognized six taxa of *Sporopodium* (four species and two varieties); several further species have eventually been recognized (Aptroot & Sipman 1993, Aptroot & al. 1997, Elix & al. 1995, Lücking 1999 & 2008, Lücking & Kalb 2002, Lücking & Lumbsch 2001, Lücking & Santesson 2002, Øvstedal & Elix 2007, Santesson & Lücking 1999). Most species are foliicolous but many can also occur on twigs, and two species are so far only known from bark.

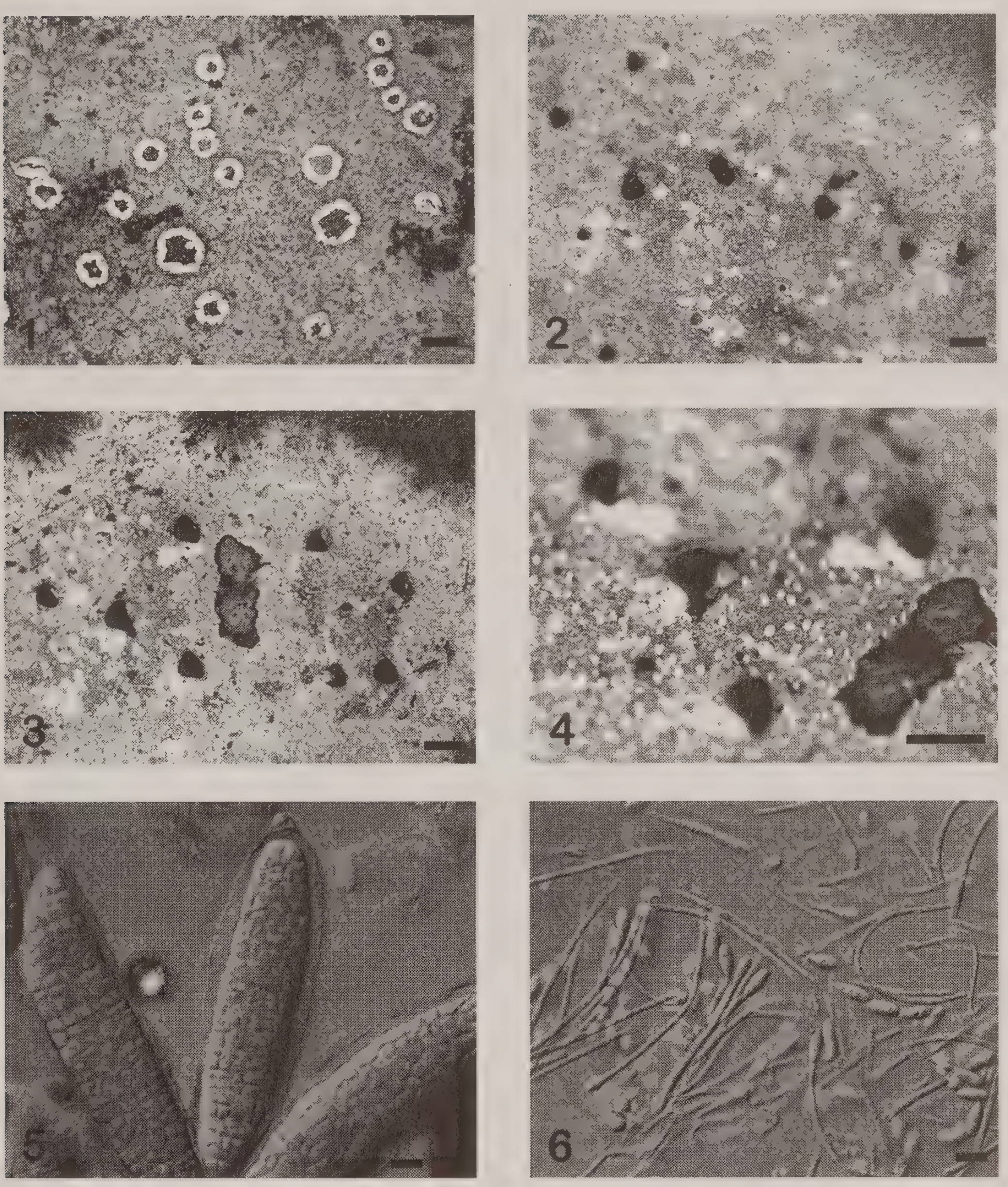
A very conspicuous species, with verrucose-isidiate thalli and large campylidia with a black lobe, is here described as new to science; it is known from Papua New Guinea and Sri Lanka. A key to all described species in the genus is presented, as well as a synopsis of the diverse secondary chemical compounds they produce.

The species

Sporopodium isidiatum Sérus. & Lücking **sp. nov** **Figs. 1-6**
MycoBank MB 511310

Ab aliis speciebus Sporopodium differt thallo isidiato et campylidiis atris.

Thallus corticolous or foliicolous, usually circular, c. 1.0-1.5 cm in diam. (largest seen: c. 2.5 cm), hardly delimited at the margins where free-living radiate hyphae may occur and thus form a whitish prothallus, continuous but formed of scattered to aggregated tiny patches at the margins; surface finely farinose, not corticated and rather matt, pale greenish to pale grey, usually with a bluish hue; verrucae always present, most probably representing genuine isidia, cylindrical and erect, c. 0.1-0.2(-0.3) mm in height and 0.05-0.1 mm in diam., regularly distributed over the thallus surface, albeit more numerous towards the center of the thallus, never branched, nor aggregated, of the same color as the thallus, filled with large, irregular oxalate crystals. Photobiont a species of the *Chlorococcaceae*, most probably *Trebouxia*. Cyanobacteria always present on the thallus surface, forming loose to compact, vermicular to granular, bluish grey to almost turquoise blue cephalodia, extensively covering large parts of the thallus; cyanobacterium a species of *Scytonema* with rare false branching, almost all trichomes with heterocysts, densely embedded by hyphae. Campylidia present on thalli not producing apothecia, all pointing in the same direction and looking like the ventilating pipes of a steamer; made of a



Figs. 1-6. *Sporopodium isidiatum*. 1. Thallus with apothecia. 2-4. Thallus with campylidia. 5. Ascospores. 6. Conidia and conidiogenous cells. 1 & 5: holotype; 2-4 & 6: Papua New Guinea, Gahavisuka, E. Sérusiaux 13762-81. Scale bars: 1-4 = 1 mm; 5-6 = 10 µm.

robust „socle" containing the conidia-producing cavity vertically connected to a tiny, laterally laid down cupula which is almost completely covered by a hood-like lobe; socle 0.4-0.5(-0.6) mm in diam., campylidium (when mature) total height 0.7-1 mm, and (seen from above) 0.5-0.8 mm for the largest dimension (width of the cupula); outer surface pale orange to brownish at the socle level, turning into dark brown to almost pure black on the covering lobe and the cupula; inner parts of the tissues forming the covering lobe and the cupula, as well as the bottom of the conidiogenous layer, with numerous, tiny, orange brown crystals that do not dissolve in K; conidiogenous cells cylindrical, 20-25

× 1-1.5 µm; conidia abundantly produced, apically arising one at a time, ellipsoid to slightly clavate, usually lacriform (the distal end rounded and the proximal one pointed, usually with an apiculus), hyaline, non-septate, 8-10 × 3(-3.5) µm; conidia accumulating in a globose, pale orange mass at the „mouth“ of the campylidium; no photobiont cells seen in the conidiogenous layer, nor in the conidial mass. Apothecia present on thalli not producing campylidia, biatorine, rounded or slightly irregular, strongly constricted at their base, 0.9-1.2 mm when fully mature, 0.3-0.4 mm in height; margin persistently strongly prominent, 0.1-0.15(-0.2) mm thick, whitish, or with a very pale yellowish-orange hue, smooth to downy, crenulate and somewhat swollen, with a few radial fissures; disc greyish to almost black, not or slightly pruinose, plane. Excipulum well-developed, typically paraplectenchymatous in its inner parts, containing numerous, tiny, orange brown crystals that do not dissolve in K, 90-100 µm thick under the hypothecium, up to 140 µm in lateral parts; hypothecium orange to brownish, not significantly changing in K; hymenium dark under the dissecting microscope for unknown reason, but hyaline when examined with the photonic microscope, c. 110-130 µm thick; paraphyses numerous, branched and anastomosed, c. 1 µm thick; asci clavate, of the *Sporopodium*-type, 100-125 × c. 25 µm; ascospores single in the asci, strongly muriform, narrowly ellipsoid, with a distinct halo (easily seen in water), 91-118 × 19-25 µm.

Chemistry: 2,7-dichlorolichexanthone (major), zeorin (major), pannarin (minor), 7-chloro-6-O-methylnorlichexanthone (minor), 2,7-dichloro-6-O-methylnorlichexanthone (minor) and 2-chlorolichexanthone (determined by HPLC and HPTLC).

Notes — *Sporopodium isidiatum* is readily recognized by its verrucose-isidiate thallus, and large and conspicuous campylidia and (when present) apothecia. Moreover the almost black color of the campylidia lobes forms a strong contrast with the white to slightly bluish thallus, and this feature is characteristic of the species.

As summarized in Tab. 1, the secondary chemical compounds produced in the genus are numerous and diverse. *Sporopodium isidiatum* is characterized by the production as major compounds of 2,7-dichloro-lichexanthone and zeorin, a combination not found in any other species.

Distribution and ecology — *Sporopodium isidiatum* is known from two localities in Papua New Guinea, in the montane forest zone (1300-2450 m), where it grows on living leaves in well-preserved stands. It must be quite rare as — although many rainforest localities have been studied in several parts of the country — *S. isidiatum* has been detected in only two. Interestingly, it was also found corticolous at a much lower elevation in Sri Lanka. The species is thus likely to be widespread in tropical S-E Asia.

TABLE 1. Secondary chemical compounds produced by *Sporopodium* species

COMPOUNDS/SPECIES	ae	an	au	ci	fl	is	li	lm	lu	ma	ph	pi	xa
XANTHONES													
Arthothelin	xx	x	xxx		x		x						x
Isoarthothelin		x	xx		x		x	x		xx			x
Asemone		x	x		x		x						x
3-O-methylasemone								x					
2-Chlorolichexanthone						x							
4-Chlorolichexanthone				x									
4-Chloro-3-O-methylnorlichexanthone				x									
4-Chloro-6-O-methylnorlichexanthone				x									
5-Chloronorlichexanthone				x									
2,5-Dichlorolichexanthone								x					
2,7-Dichlorolichexanthone					x	xxx							x
4,5-Dichlorolichexanthone				x									
5,7-Dichlorolichexanthone					x			x					x
2,7-Dichloro-6-O-methylnorlichexanthone						x							
4,5-Dichloro-6-O-methylnorlichexanthone				x									
5,7-Dichloro-3-O-methylnorlichexanthone					x			x	xx	xxx	x		x
4,5-Dichloronorlichexanthone	xx												
5,7-Dichloronorlichexanthone					x								x
2,4,5-Trichlorolichexanthone								x					
2,5,7-Trichlorolichexanthone					x								x
2,5,7-Trichloro-3-O-methylnorlichexanthone					x				xx	xxx	x		x
4,5,7-Trichlorolichexanthone								x					
7-Chloro-6-O-methylnorlichexanthone						x							
Chodatin								x					
Thiophanic acid	xxx	x	xxx		x		x						x
Vinetorin				x									
DEPSIDES AND DEPSIDONES													
Atranorin												x	
Methylbarbate								xxx					
Argopsin		x					x						
Pannarin					x	x			xx		x	x	x
TRITERPENOIDS													
Zeorin		x	xx	x	x	xxx	x				x	x	x
VULPINIC ACID DERIVATIVES AND DIBENZOFURANES													
Vulpinic acid									xxx				
Isousnic acid	xx												
Usnic acid	xxx												

ae= *aeruginascens*, an = *antonianum*, au = *aurantiacum*, ci = *citrinum*, fl = *flavescens*, is = *isidiatum*, li = *leprieurii*, lm = *leprosum*, lu = *lucidum*, ma = *marginatum*, ph = *phyllocharis*, pi = *pilocarpoides*, xa = *xantholeucum*.

SPECIMENS EXAMINED — PAPUA NEW GUINEA: Madang prov., S side of Ramu river, Bundi village, along the road to Bundi Gap, 5°44.9'S 145°14.1'E, 1300-1500 m, forested slope, foliicolous, Nov. 1995, E. Sérusiaux 16609 (LG—holotypus, F—isotypus). Eastern Highlands prov., Gahavisuka Provincial Park, 11 km N of Goroka, 6°01'S 145°25'E, 2300-2450 m, little disturbed mossy mountain forest, Aug. 1992, E. Sérusiaux 13762-81 (LG, F). SRI LANKA: Southern prov., Galle distr., Kanneliya Forest, 1 km N of forestry bungalows, 6°15'N 80°22'E, 90 m, corticolous, March 1978, G. Thor 583 (S).

Key to all known species of *Sporopodium*

1a Thallus or reproduction organs distinctly (citrine) yellow or orange 2
1b Thallus or reproduction organs not distinctly yellow or orange [campylidia and apothecial margins sometimes pale yellow to pinkish orange] 7

2a Thallus (at least parts of it, mainly near apothecia and campylidia), campylidia and apothecia yellow or orange 3
2b Thallus bluish, apothecial margin grey to whitish, campylidia bright yellow 4

3a Thallus, apothecia (mainly margins) and campylidiapale to bright orange; apothecial margin smooth .... [pantropical] ***Sp. aurantiacum*** (Zahlbr.) Lücking
3b Thallus lemon green, apothecia (mainly margins) and campylidia bright lemon yellow; apothecial margin slightly crenulate............................... ....[tropical Asia, New Guinea] ***Sp. lucidum*** Aptroot & Sipman

4a Thallus distinctly verrucose; apothecial margin irregular or slightly crenulate ... 5
4b Thallus smooth or with scattered, indistinct, low verrucae; apothecial margin smooth or almost so 6

5a Verrucae irregularly papillose, with a thinly pruinose to pilose surface; thallus with usnic and isousnic acid, and dichloro- and trichlorolichexanthones .... [neotropical] ***Sp. aeruginascens*** Lücking & Lumbsch
5b Verrucae regular and smooth; thallus with zeorin, together with chloro- and dichlorolichexanthones ..... [pantropical] ***Sp. citrinum*** (Zahlbr.) Elix & al.

6a Thallus smooth or with scattered, indistinct, low verrucae; base of campylidia well-developed, usually broader and larger than the lobe, and thus the most conspicuous part of the campylidium .... [eastern paleotropics] ***Sp. flavescens*** (R. Sant.) Vezda
6b Thallus smooth; base of campylidia reduced and thus the lobe being the most conspicuous part of the campylidium ... [amphipacific] ***Sp. subflavescens*** Lücking

7a Verrucae always distinct; thallus usually greyish to pale greenish grey *or* with a bluish tinge 8
7b Verrucae absent, or scattered, indistinct or low; thallus usually bluish grey 13

8a Thallus coarsely verrucose to isidiate; campylidia with a blackish brown to pure black lobe; thallus with a bluish tinge [tropical Asia and New Guinea] ***Sp. isidiatum***
8b Thallus finely verrucose, not isidiate; campylidia with a light to dark brown lobe; thallus usually without a bluish tinge 9

9a Prothallus typically present, woolly, of loosely interwoven hyphae, very similar to that produced by *Lasioloma* species; apothecial margin with tiny hairs.......... .... [pantropical] ***Sp. antonianum*** Elix & al.

9b Prothallus not woolly; apothecial margin without hairs 10

10a Apothecial margin smooth or almost so, hardly raised 11

10b Apothecial margin irregular or thick, crenulate, and raised 12

11a Apothecial disc non-pruinose; campylidia with a distinct socle and a rather small, usually dark brown lobe.. .... [pantropical] ***Sp. leprieurii*** Mont.

11b Apothecial disc pruinose; campylidia without a distinct socle and with a large, brownish lobe .... [neotropical and Africa] ***Sp. pilocarpoides*** (Zahlbr.) Lücking & Kalb

12a Apothecia 0.8-1.4 mm in diam., disc with spreading masses of torulose hyphae .... [New Guinea] ***Sp. muscicola*** Lambley & Sérus.

12b Apothecia 0.5-0.8 mm in diam., disc smooth............................... .... [tropical Asia] ***Sp. argillaceum*** (Müll. Arg.) Zahlbr.

13a Thallus C and KC + orange, (containing methyl barbatate);apothecia unknown .... [neotropical] ***Sp. leprosum*** Øvstedal & Elix

13b Thallus C and KC -; apothecia present or absent 14

14a Ascospores 8/ascus; campylidia unknown .... ***Sp. octosporum*** Lücking

14b Ascospores single in the ascus; campylidia usually present 5

15a Conidia 1-septate, distal cell rounded and proximal cell ellipsoid-bacillar; campylidia with reduced socle and a large, greyish lobe with a whitish gray pruina .... [tropical Africa] ***Sp. podosphaera*** Lücking & R. Sant.

15b Conidia non-septate, ellipsoid to guttuliform; campylidia without pruina 16

16a Apothecia irregular, with thickly pruinose margin; campylidial wall paraplectenchymatous throughout; campylidia often pale yellowish .... [pantropical] ***Sp. xantholeucum*** (Müll. Arg.) Zahlbr.

16b Apothecia regularly rounded; campylidial wall in most parts prosoplectenchymatous; campylidia usually pale grey 17

17a Apothecial margin prominent, pale orange to pinkish; pannarin and zeorin absent .... [amphipacific] ***Sp. marginatum*** Lücking

17b Apothecial margin not prominent, pale grey to whitish, pannarin and zeorin present ... . [pantropical] ***Sp. phyllocharis*** (Mont.) A. Massal.

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Literature cited

Andersen HL, Ekman S. 2005. Disintegration of the *Micareaceae* (lichenized *Ascomycota*): a molecular phylogeny based on mitochondrial rDNA sequences. Mycological Research 109: 21-30.

Aptroot A, Diederich P, Sérusiaux E, Sipman HJM. 1997. Lichens and Lichenicolous Fungi from New Guinea. Bibliotheca Lichenologica 64, 220 p.

Aptroot A, Sipman H. 1993. *Musaespora*, a genus of pyrenocarpous lichens with campylidia, and other additions to the foliicolous lichen flora of New Guinea. Lichenologist 25: 121-135.

Elix JA, Lumbsch HT, Lücking R. 1995. The chemistry of foliicolous lichens. 2. Constituents of some *Byssoloma* and *Sporopodium* species. Bibliotheca Lichenologica 58: 81-96.

Lücking R. 1999. Ergänzungen und Verbesserungen zur Kenntnis der foliikolen Flechtenflora Costa Ricas. Die Familie *Ectolechiaceae.* Phyton 39: 131-165.

Lücking R. 2008. Foliicolous lichens. Flora Neotropica Monograph (in press).

Lücking R, Kalb K. 2002. New species and further additions to the foliicolous lichen flora of Kenya (East Africa), including the first lichenicolous *Aulaxina* (*Ostropales: Gomphillaceae*). Botanical Journal of the Linnean Society 139: 171-180.

Lücking R, Lumbsch HT. 2001. New species or interesting records of foliicolous lichens. VI. *Sporopodium aeruginascens* (*Lecanorales*), with notes on the chemistry of *Sporopodium.* Mycotaxon 78: 23-27.

Lücking R, Lumbsch HT, Elix JA. 1994. Chemistry, anatomy and morphology of foliicolous species of *Fellhanera* and *Badimia* (lichenized *Ascomycotina: Lecanorales*). Botanica Acta 107: 393-401.

Lücking R, Santesson R. 2002. On the identity of *Pyrenotrichum* '*atrocyaneum*', *P.* '*mirum*', and '*P.* '*podosphaera*', campylidia of lichenized *Ascomycota* (*Lecanorales: Ectolechiaceae*). Bryologist 105: 57-62.

Øvstedal DL, Elix JA. 2007. Three new lichen species from the French Antilles. Mycotaxon 99: 91-97.

Santesson R. 1952. Foliicolous lichens I. A revision of the taxonomy of the obligately foliicolous, lichenized fungi. Symb. Bot. Upsal. 12(1), 590 p.

Santesson R, Lücking R. 1999. Additions to the foliicolous lichen flora of the Ivory Coast and Guinea (Tropical West Africa). Nord. J. Bot. 19: 719-734.

Sérusiaux E. 1986. The nature and origin of campylidia in lichenized fungi. Lichenologist 18: 1-35.

Vězda A. 1986. Neue Gattungen der Familie *Lecideaceae* s. l. (Lichenes). Folia Geobot. Phytotax. (Praha) 21: 199-219.

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Taxonomic studies of *Alternaria* from China 11. Three large-spored new species

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Abstract — Three large-spored new species in the genus *Alternaria*: *A. amphicarpaeae* and *A. sojae* on plants of *Fabaceae* and *A. tribuli* on *Zygophyllaceae* are reported. *A. amphicarpaeae* and *A. sojae* are morphologically distinguishable from each other, and are also different from the other reported species of *Alternaria* on *Fabaceae*. *Alternaria tribuli* is the first species of *Alternaria* reported on *Zygophyllaceae*. Type specimens are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP) and the Herbarium of Henan Agricultural University: Fungi (HHAUF).

Key words — taxonomy, hyphomycetes, leaf spots

In the course of a survey of mitosporic fungal pathogens of important weeds, three new taxa of *Alternaria* were found on *Amphicarpaea edgeworthii*, *Glycine soja* and *Tribulus terrestris* in Shandong Province and Henan Province of China. They are described as follows.

Alternaria amphicarpaeae Meng Zhang & T.Y. Zhang, **sp. nov.** FIGURE 1

MycoBank MB 511321

Conidia solitaria, obclavata, obpyriformia vel ovoidea, recta, subhyalina vel pallide brunnea, septa transversa 5–8, septa longitudinalia vel obliqua 2–6, constricta, 50–70 × 15.5–22µm, rostra filiformia, septata, hyalina, 54–140 × 2–3µm .

Holotype: on leaf spots of *Amphicarpaea edgeworthii* Benth.: Taian, Shandong Province, China, leg. M. Zhang, Jun. 2003, *HSAUP*$_{03}$*0635* (=*ZM*$_{03}$*0135*, dried cultures on PCA + filter paper).

Leaf spots circular or irregular, pale brown in the central area, with dark brown margins, 3–6 mm in diameter. Colonies on PCA greyish brown, velvety, effuse,

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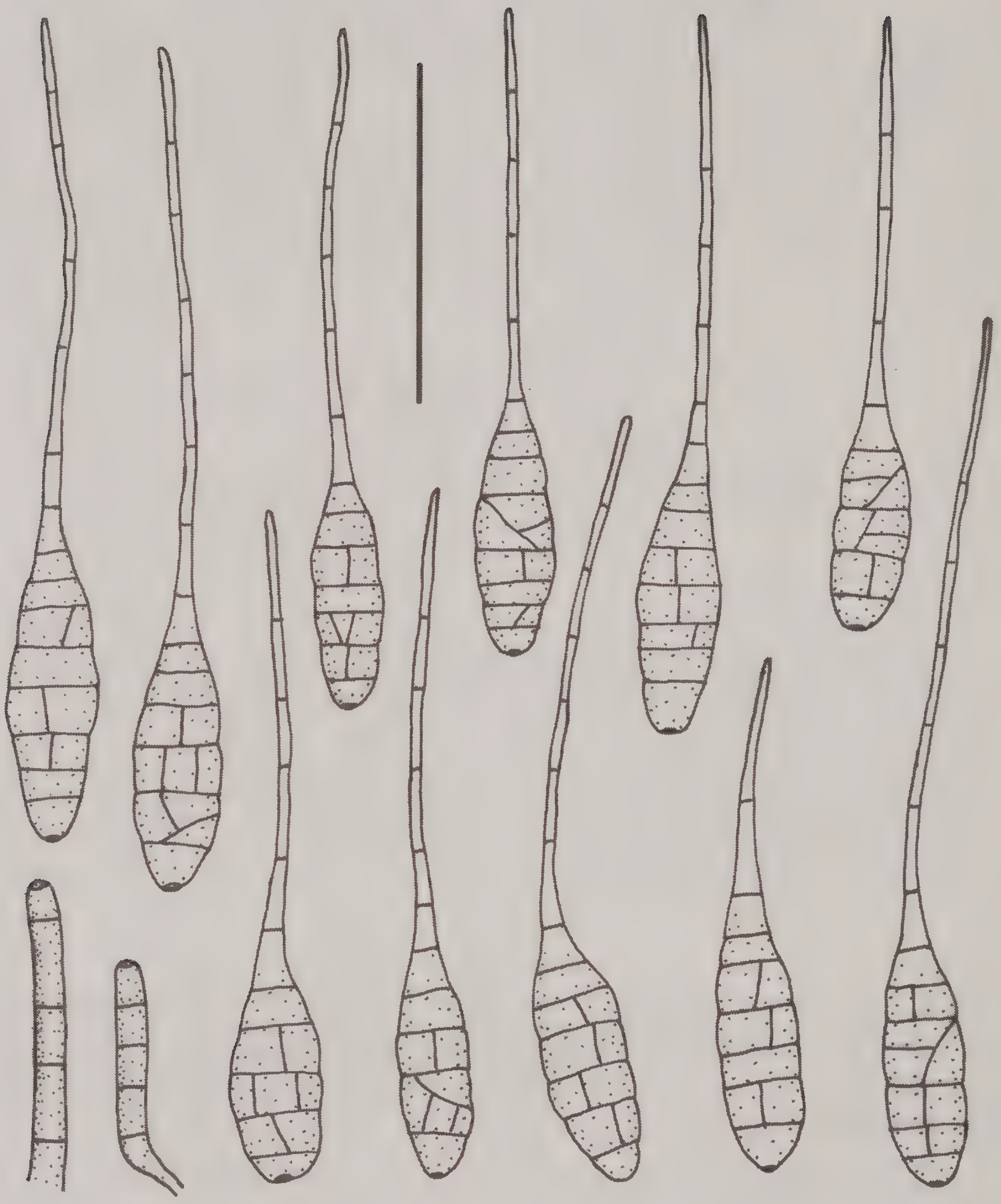

FIGURE 1 *Alternaria amphicarpaeae*
Conidia and conidiophores on PCA + filter paper. (ex holotype, bar=50µm)

sporulating sparsely. On PCA + filter paper sporulating freely. Conidiophores arising singly, terminally or laterally from hyphae, simple, straight or curved, smooth-walled, septate, pale brown, 39–78 × 6–9µm. Conidia obclavate or obpyriform, base obtuse, straight, subhyaline to pale brown, smooth–walled, with 5–8 transverse septa and 2–6 longitudinal or oblique septa, constricted at some main septa, 50–70 × 15–22µm, av. 59.5 × 19.5µm. Rostra long, filiform, straight, septate, hyaline, 54–140 × 2–3µm.

Alternaria amphicarpaeae is similar to *A. cassiae* Jurair & A. Khan and *A. longirostrata* T.Y. Zhang & Meng Zhang in conidium morphology. The main distinctions between them are the conidium size range and shape. The conidia of *A. cassiae* (the description of original authors: 92–332 × 28–40µm; the description of E.G. Simmons: the body of conidia 65–90 × 20µm; Simmons 1982) are obviously larger than those of this new fungus. The conidia of *A. longirostrata* are narrower (av. 17.4µm) and its conidium rostra are distinctly longer (av. 180.5µm; Zhang et al. 2003) than those of the present fungus. Additionally, the light coloured conidia of *A. amphicarpaeae* are very helpful in distinguishing it from the other *Alternaria* species on plants of *Fabaceae.*

Alternaria sojae Meng Zhang & T.Y. Zhang, **sp. nov.** FIGURE 2

MycoBankMB 511324

> *Conidia solitaria, raro in catenis bisporis, fusiformia vel ellipsoidea, attenuata versus basim angustam, laevia, pallide brunnea, 4–12 transversa septa, 2–9 longitudinalia vel obliqua septa, constricta, 80–103 × 20–31.5µm, rostra vel pseudorostra filiformia, hyalina, 75–350 × 2–3µm.*
>
> *Holotype: on leaf spots of Glycine soja Siebold & Zucc.: Luoyang, Henan Province, China, leg. M. Zhang, Oct. 2005, HHAUF* $_{05}$ *0360 (=ZM* $_{05}$ *0360, dried cultures on PCA).*

Leaf spots circular or subcircular, brown to black, 3–6mm in diameter. Colonies on PDA grey-brown, velvety, effuse, no sporulation. Colonies on PCA grey, velvety, effuse, sporulating freely. Conidiophores arising singly, terminally or laterally from hyphae, simple, straight or curved, smooth–walled, septate, medium brown, paler toward the apex, 70–156 × 4.5–6.5µm. Conidia fusiform or ellipsoidal, gradually subulate from the lower-middle toward the base, medium brown, smooth-walled, with 4–12 transverse septa and 2–9 longitudinal or oblique septa, 80–103 × 20–31.5µm. Rostra or pseudorostra very long, filiform, straight, sometimes curved, hyaline, 75–350 × 2–3µm, the apex of pseudorostra swollen to 4.5 µm wide.

The new species has the largest conidia of any *Alternaria* thus far described on *Fabaceae*. Its characteristic large, fusiform conidia and long filamentous rostra or pseudorostra are very useful in separating it from all other *Alternaria* species described from this plant family.

Alternaria tribuli Meng Zhang & T.Y. Zhang, **sp. nov.** FIGURE 3

MycoBank MB 511325

> *Conidia solitaria, obclavata vel obpyriformia, recta, pallide brunnea vel moderate brunnea, 3–8 transversa septa, 0–1–4 longitudinalia vel obliqua septa, partim constricta, crassa, 31–62 × 11–17.5µm. Rostra filiformia, septata, subhyalina, 50–190 × 2–3µm .*
>
> Holotype: on leaf spots of *Tribulus terrestris* L.: Taian, Shandong Province, 2003, Coll. M. Zhang., *HSAUP*$_{03}$ *0700* (=*ZM*$_{03}$ *0200*, dried cultures on PCA).

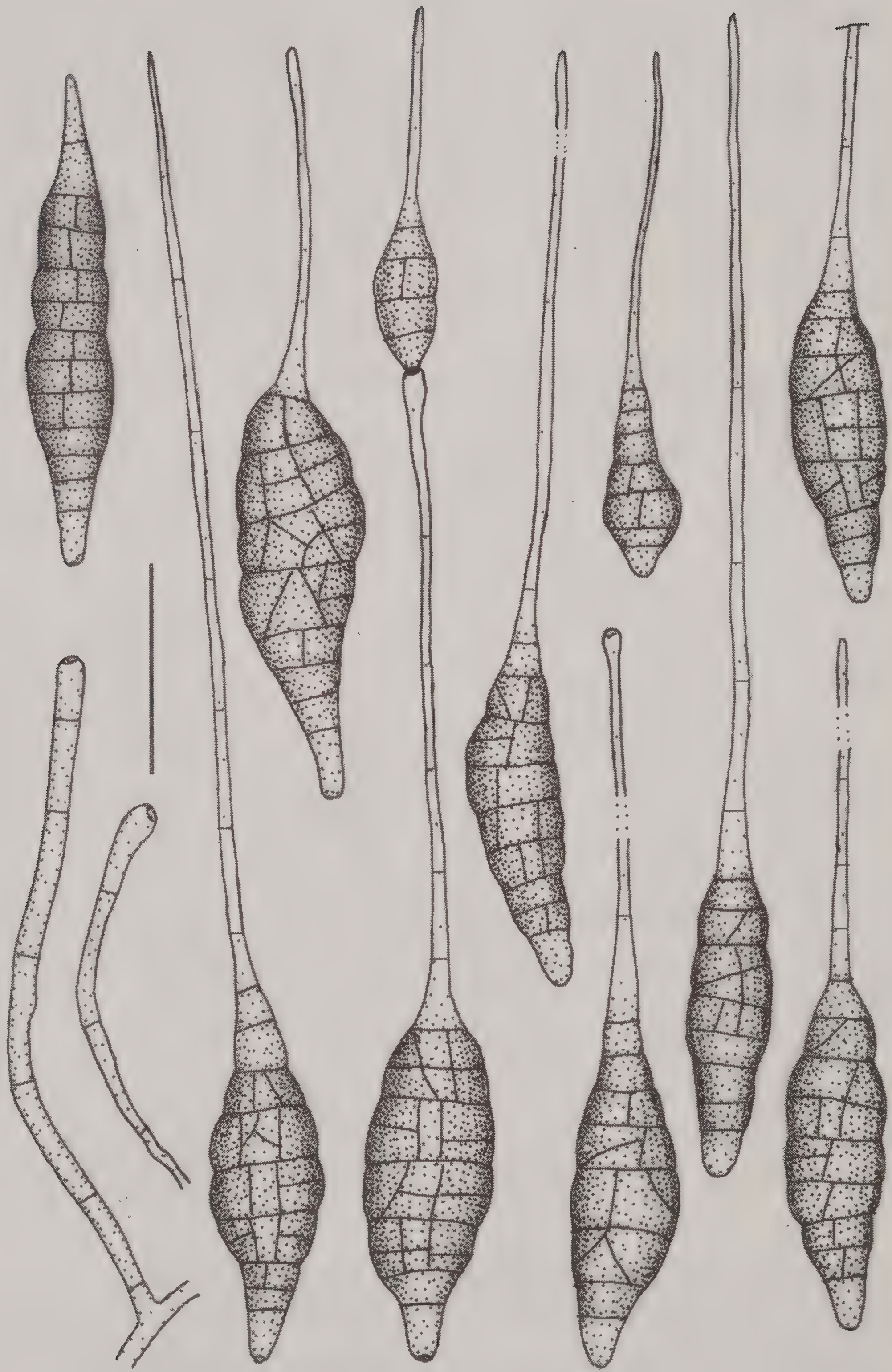

FIGURE 2 *Alternaria sojae*
Conidia and conidiospores on PCA. (ex holotype, bar=50µm)

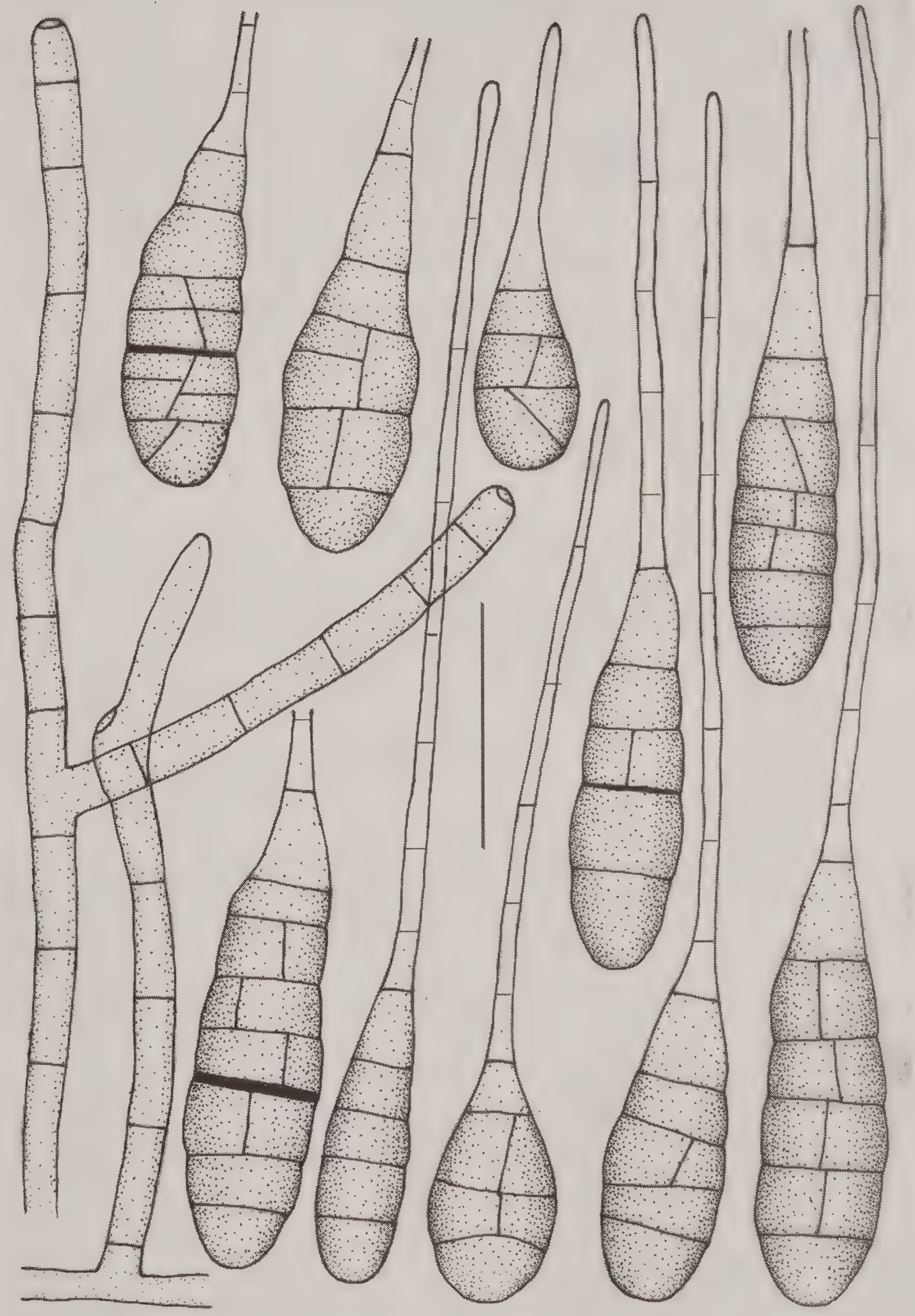

FIGURE 3 *Alternaria tribuli*
Conidia and conidiophores on PCA + filter paper. (ex holotype, bar=30μm)

Leaf spots subcircular or irregular, pale brown, 2–4mm in diameter. Colonies on PCA grey, velvety, effuse, sporulating sparsely. On PCA + filter paper sporulating freely. Conidiophores arising singly, terminally or laterally from hyphae, simple or branched, straight or curved, smooth–walled, septate, pale brown, paler toward the apex, 60–175 × 4.5–6.5µm. Conidia obclavate or obpyriform, pale brown to medium brown, smooth–walled, with 3–8 transverse septa and 0–1–4 longitudinal or oblique septa, constricted and thickened at some septa, 31–62 × 11–17.5µm, av. 47.5 × 15µm. Rostra filiform, straight, sometimes curved, subhyaline, 50–190 × 2–3µm.

This is the first species of *Alternaria* reported on *Zygophyllaceae.*

Acknowledgments

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Literature cited

Simmons EG. 1982. *Alternaria* themes and variations (7-10). Mycotaxon, 14 (1): 17-43.

Zhang TY, Zhang JZ, Chen WQ, Zhang M, Sun GY, Gao MX. 2003. Flora Fungorum Sinicorum, 16: *Alternaria*. BeiJing: Science Press, 1–283 + Plates (in Chinese).

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Taxonomic studies of *Alternaria* from China 12. Three taxa on *Paeonia suffruticosa*

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Abstract — Three species of *Alternaria* on *Paeonia suffruticosa* are reported: *A. suffruticosae, A. suffruticosicola,* and *A. tenuissima.* The first two taxa are described as new species. *A. suffruticosae* is the first large-spored *Alternaria* species reported on plants of the family *Ranunculaceae. A. suffruticosicola* differs from other species reported on *Ranunculaceae* by its characteristic *Alternaria infectoria*-like sporulation pattern. Type specimens are deposited in the Herbarium of Henan Agricultural University: Fungi (HHAUF).

Key words — taxonomy, hyphomycetes, leaf spots

In the course of a survey of pathogenic fungi of *Paeonia suffruticosa* Andrews in Henan Province, three taxa of *Alternaria* were found. Two of them are new species. We describe them as follows.

Alternaria suffruticosae Meng Zhang, Z.S. Chen & T.Y. Zhang, **sp. nov.** FIGURE 1
MYCOBANK MB 511326

Conidia solitaria, obclavata, obpyriformia vel ovoidea, recta, moderate brunnea vel brunnea, transverse 4–10-septata, longitudinaliter vel obique 2–8-septata, constricta, 50–100 × 19–28µm, rostra filiformia, hyalina, 120.5–225 × 2.5–3.5µm.

HOLOTYPE: on leaf spots of *Paeonia suffruticosa*: Zhengzhou, Henan Province, 2006, Coll. M. Zhang and Z. S. Chen, *HHAUF* $_{06}$ *0572–1=ZM* $_{06}$*0572–1,* dried cultures on PCA+ filter paper.

Leaf spots circular or irregular, brown to black, 3–10mm in diameter. Colonies on PDA brown, velvety, effuse, no sporulation. Colonies on PCA grayish-brown, velvety, effuse, sporulating sparsely. On PCA + filter paper sporulating freely. Conidiophores arising singly or in groups terminally or laterally from hyphae,

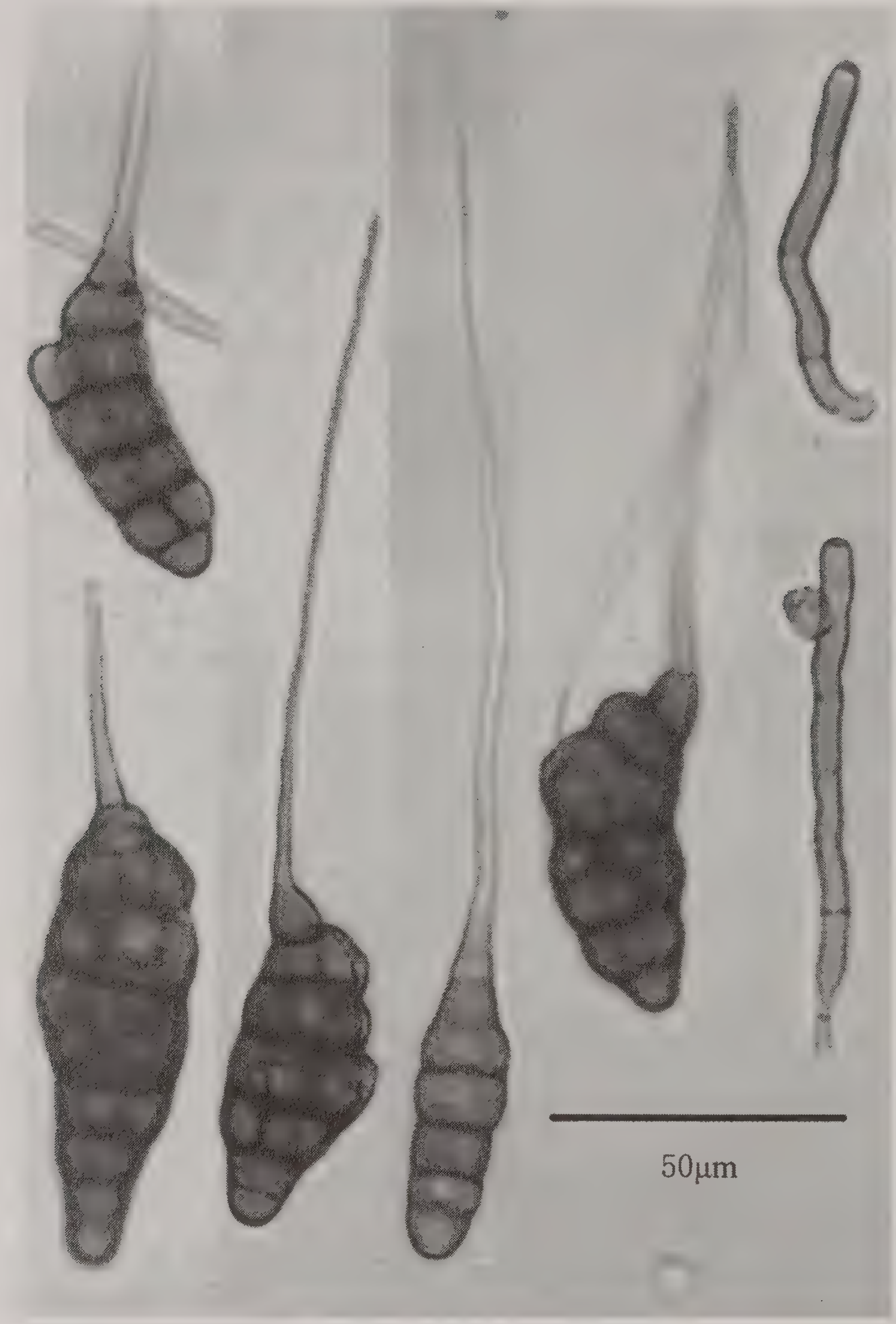

Figure 1 *Alternaria suffruticosae*
Conidia and conidiophores on PCA + filter paper. (ex holotype)

simple, straight or curved, smooth-walled, septate, pale brown, paler toward the apex, 60–93 × 4–6μm. Conidia ovoid, obpyriform or obclavate, medium brown to brown, smooth-walled, with 4–10 transverse septa and 2–8 longitudinal or oblique septa, some conidial cells bulge to one side, 50–100 × 19–28μm. Rostra filiform, long, straight or slightly curved, subhyaline, 120–225 × 2.5–3.5μm.

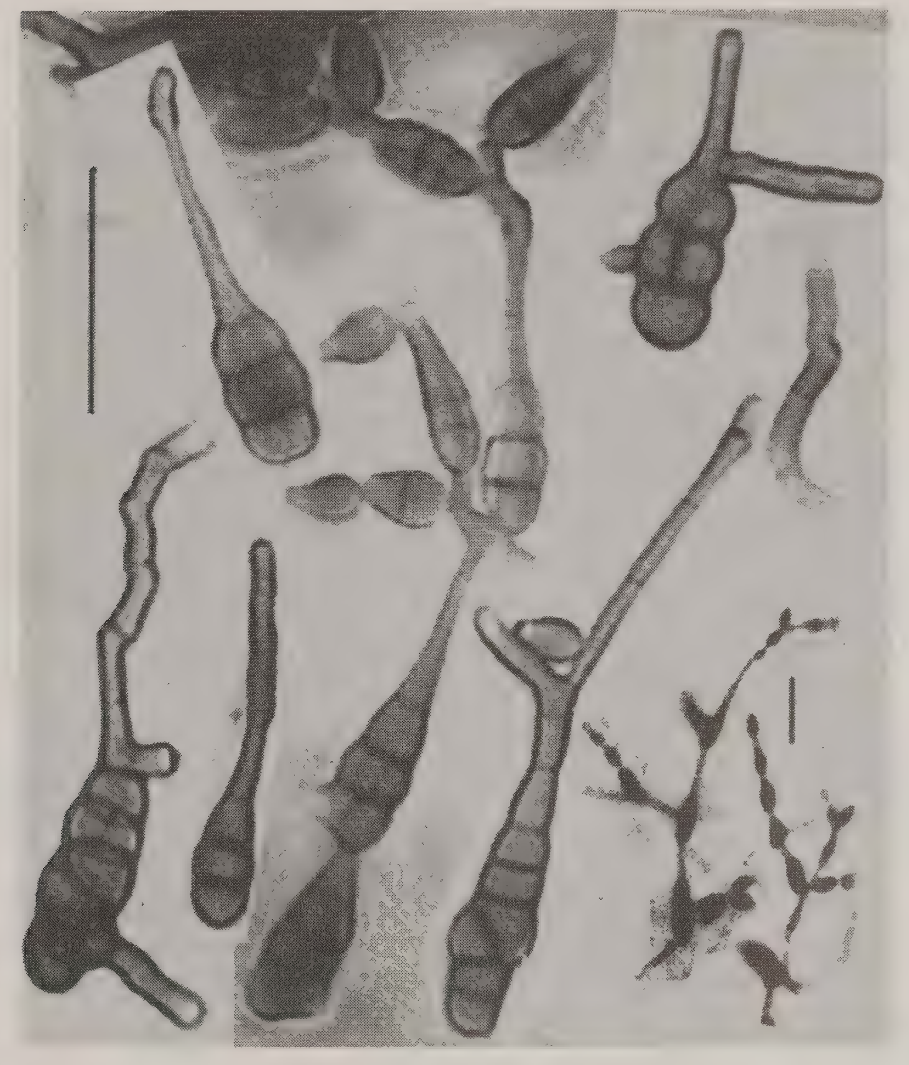

FIGURE 2 *Alternaria suffruticosicola*
Conidia, conidiophores and sporulation patterns on PCA + filter paper.
(ex holotype, all bars=30µm)

Alternaria suffruticosicola Meng Zhang, Z.S. Chen & T.Y. Zhang, **sp. nov.** FIGURE 2
MYCOBANK MB 511327

Conidiophora solitaria, pallide brunnea, erecta, septata, 20–50 × 4–5.5µm. Conidia catenulata, obclavata vel ellipsoidea, recta, pallide brunnea vel medio-brunnea, septa transversa 2–6, septa longitudinalia vel obliqua 0–1–3, partim constricta, 13–40 × 7.5–11.5µm. Rostra curta vel nulla, pseudorostra cylindrica, simplicia vel ramosa, septata, subhyalina, apice inflata, 3–57 × 2–4.5µm.

HOLOTYPE: on leaf spots of *Paeonia suffruticosa*: Zhengzhou, Henan Province, 2006, Coll. M. Zhang and Z. S. Chen, *HHAUF* $_{06}$ *0572–2=ZM* $_{06}$ *0572–2*, dried cultures on PCA+ filter paper.

Leaf spots circular or irregular, brown to black, 3–10mm in diameter. Young colonies (5–7 d) on PCA greyish brown, velvety, effuse, sporulating freely. Conidiophores arising singly, terminally or laterally from hyphae, simple, straight or curved, smooth-walled, septate, pale brown, paler toward the apex, 20–50 × 4–5.5µm. Conidia catenulate, obclavate or ellipsoidal, pale brown to medium brown, smooth-walled, with 2–6 transverse septa and 0–1–3 longitudinal or oblique septa, constricted at some septa, 13–40 × 7.5–11.5μm. Rostra short or none; pseudorostra commonly produced from any cells of conidia, simple or branched, straight or curved, sometimes apex geniculate and inflated, subhyaline to pale brown, septate, 3–57 × 2–4.5μm.

A. suffruticosae and *A. suffruticosicola* occur on the same leaf spots of *Paeonia suffruticosa*. But they are morphologically distinguishable from each other. There are three previously reported species of *Alternaria* on *Ranunculaceae*. One is *Alternaria tenuissima* on *Ranunculus asiaticus* L. Zhang et al. 2003, The second is *Alternaria thalictrina* Ondřej on *Thalictrum aquilegiifolia* L. (Ondřej 1974). The third is *Alternaria thalictricolor* Y.L. Guo on *Thalictrum macrorhynchum* Franch. (Guo 1999). The conidia of *A. suffruticosae* is obviously bigger than those of the three reported species. It is also the first large-spored species of *Alternaria* on *Ranunculaceae* with a long filamentous beak. The sporulation patterns of *A. suffruticosicola* belong to those of the *Alternaria infectoria* species-group; individual sporulation clumps are relatively open; the pseudorostra of main central conidia in the chains are usually longer than conidia that produce them. Therefore it is different from other reported species of *Alternaria* on *Ranunculaceae*.

Alternaria tenuissima (Kunze) Wiltshire (1933), Trans. Brit. Mycol. Soc. 18: 157.

≡ *Helminthosporium tenuissimum* Kunze (1818), in Nees & Nees, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 9: 242.

≡ *Macrosporium tenuissimum* (Kunze) Fr. (1832), Syst. Mycol. 3: 374.

= *Alternaria humicola* Oudem. (1902), Arch. Néerl. Sci. Exact. Nat. 7: 292.

Specimen: on leaf spots of *Paeonia suffruticosa*: Luoyang, Henan Province, 2006, Coll. M. Zhang and Z.S. Chen, *HHAUF* $_{06}$ *0468 (=ZM* $_{06}$ *0468)*.

A. tenuissima is a very familiar species of *Alternaria* reported on various substrates. It also occurs on leaf spots of *Paeonia suffruticosa,* the spots circular or irregular, brown to black, 3–7mm in diameter.

Acknowledgments

The authors are grateful to Drs. B. Kendrick, Canada, and Prof. J.Y. Zhuang, Institute of Microbiology, Academia Sinica, for reviewing the manuscript.

Literature Cited

Guo YL. 1999. New species of *Alternaria*. Journal of Anhui Agricultural University, 26 (supplement, in Chinese): 44–45.

Ondřej M. 1974. Parasitic imperfect fungi of the genus *Alternaria* Nees from Moravia. Cas. slezsk. Mus. Opave, A, **23**(2): 145–152.

Zhang TY, Zhang JZ, Chen WQ, Zhang M, Sun GY, Gao MX. 2003. Flora Fungorum Sinicorum, 16: *Alternaria*. BeiJing: Science Press, 1–283 + Plates (in Chinese).

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Pluteus neotropicalis (*Pluteaceae, Agaricales*), a new species from tropical-subtropical Mexico

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Abstract — The new species *Pluteus neotropicalis* occurs in habitats situated in tropical and subtropical regions in the states of Colima, Quintana Roo, and Veracruz, Mexico. Morphologically, *P. neotropicalis* is most closely related to the northern temperate *P. thomsonii*, from which it is differentiated by its obtuse and short rostrate cystidia.

Key words — agaric, *Basidiomycota, Celluloderma, Pluteus thomsonii*

Introduction

The majority of *Pluteus* Fr. species have been described from temperate regions, with comparatively few taxa reported from the tropics. In Mexico, *Pluteus* species have been studied by Singer (1973), Cifuentes & Guzmán (1981), Candusso et al. (1994), Rodríguez & Guzmán-Dávalos (1997, 1999, 2000, 2001), Ramírez-Guillén & Guzmán (2003), Rodríguez et al. (1997, 2004), and Rodríguez (2005). So far, thirty three species of *Pluteus* have been reported from Mexico (Rodríguez 2005). Several of those occur in tropical-subtropical habitats, e.g. *Pluteus aethalus* (Berk. & M.A. Curtis) Sacc., *P. horridus* Singer, *P. leucocyanescens* Singer, *P. oligocystis* Singer, and *P. triplocystis* Singer from tropical rain forests; *P. martinicensis* Singer & Fiard from deciduous tropical forests (Rodríguez 2005), and *P. xylophilus* (Speg.) Singer from subtropical and pine-oak forests (Ramírez-Guillén & Guzmán 2003, Rodríguez 2005).

Below we describe a new species of *Pluteus* collected from tropical-subtropical forests that includes one collection (Guzmán 30963) previously indicated as Ramírez-Guillén (1998) representing a probable new taxon.

Material and methods

Microscopic observations were made from sections of basidiomata mounted in 3 % KOH solution. Basidiospore shape was determined according to Bas (1969) using the Q coefficient (length-width ratio) determined from 20 randomly selected basidiospores. Descriptive terms follow Vellinga (1998).

Taxonomy

Pluteus neotropicalis O. Rodr.-Alcántar, **sp. nov.** FIGS. 1-6
MYCOBANK MB 511284

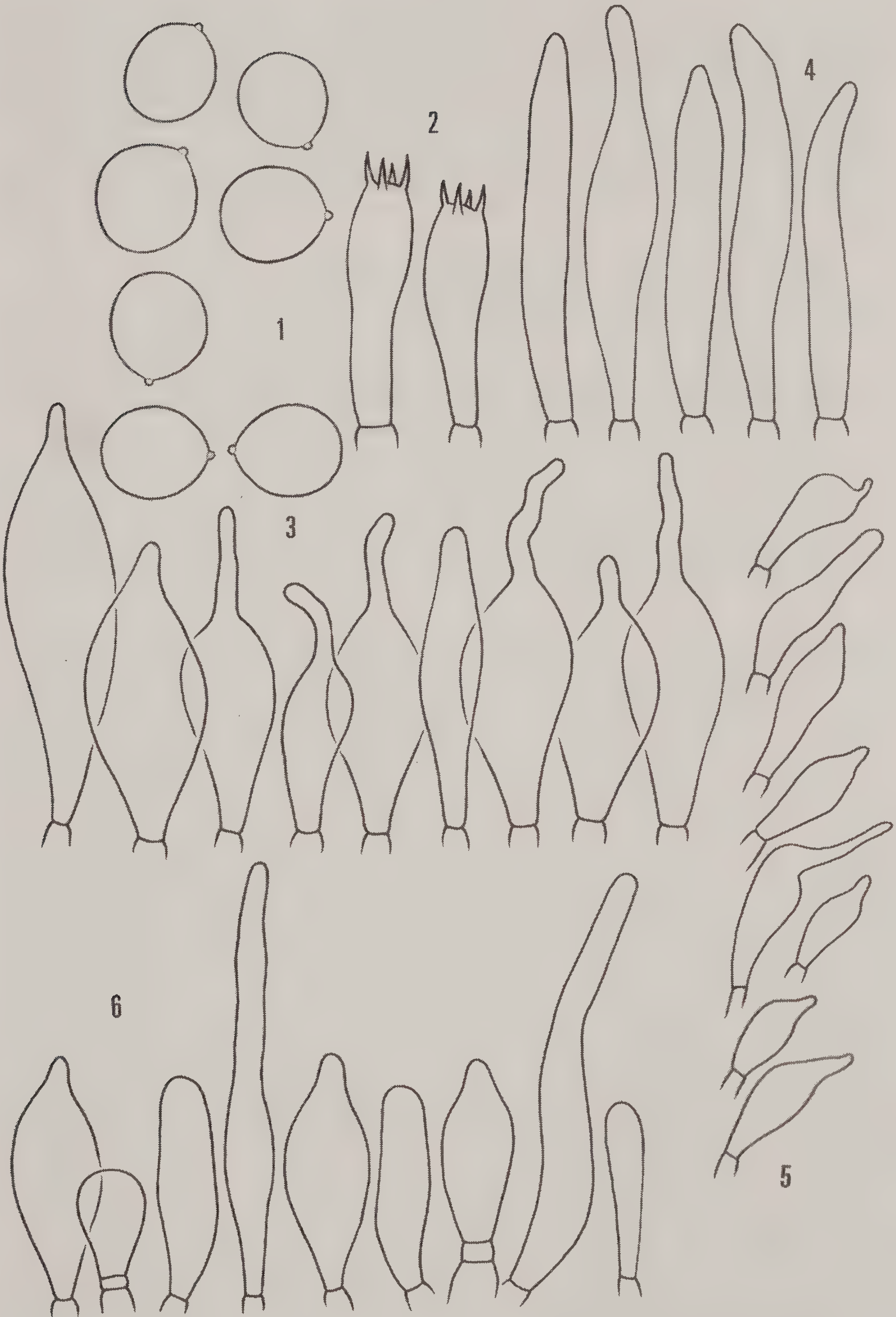
Pileus 10-18 mm latus, marginem pallidiorem versus striato-sulcatus, velutinus, ad discum rugosovenosus, griseo-brunneus vel rubellus-brunneus. Lamellae confertae, ventricosae, albidae vel roseae, ad aciem subfimbriatae, haud coloratae. Stipes 12-22 × 1-2 mm, centralis, basim versus glaber vel floccosus, albido-griseus dein brunneus. Sporae 5.5-7(-8) × (4-) 5-6 μm, subglobosis vel late ellipsoideis, laevis, subcrassus tunicatus (0.8 μm), hyalinis. Cheilocystidia (et pleurocystidia valde similia) 32-62.5(-68.5) × 10-19(-23)μm, fusiformia vel claviformia, apicaliter rostro 5-28 μm longlongo et obtuso frequenter instructa, abundantes. Pileipellis typi Mixtini, cellulae subglobosae, ellipsoideaes vel claviformia compositus, 17-45 × 12-21(-28) μm, pileocystidia 42.5-67.5 × (9.5-)10-19(–20) μm, anguste utriformia, lageniformia vel fusiformia, saepe mucronata, pigmento brunneolo instructa. Caulocystidia (15-)25-61(-67.5) × (6-) 10-15 (-23.5) μm, cheilo- et pleurocystidiis similia, hyalina. Fibulae nullae. Ad lignum putridum. Mexico. Holotypus G. Guzmán 20644 (XAL).

HOLOTYPUS: Mexico, Quintana Roo: Municipality of Felipe Carrillo Puerto, 4.XI.1981, G. Guzmán 20644 (XAL).

ETYMOLOGY: *neotropicalis*, named based on its neotropical distribution.

PILEUS 10-18 mm broad, conic-campanulate when young, convex to plane in mature specimens, margin striate-sulcate, surface velutinous, wrinkled or venose in the disk, at first grayish-brown to reddish-brown in center, light brown, pinkish-brown to yellowish-brown upon drying or in age, dry. LAMELLAE free, crowed, ventricose, at first whitish, gradually becoming pink; entire or fimbriate, concolorous edges. STIPE 12-22 × 1-2 mm, central, equal or slightly enlarged towards base, fragile, minutely pruinose, floccose near base, brown with whitish-grayish or pink tinges, with whitish mycelium at base. CONTEXT concolorous, unchanging upon exposure. BASIDIOSPORES 5-6 (-7) × (4-) 4.5-5.5 (-6) μm, Q = 1.05-1.15 (-1.25), suglobose or globose (rarely broadly ellipsoid), smooth, thin-walled, with refringent content, hyaline.

BASIDIA 24-28 × (6.5-) 7-8 (-11) μm, 4-spored, subclavate, hyaline, clampless. CHEILOCYSTIDIA 25-45 (-62.5) × 7-15 (-19) μm, slender fusoid or broadly fusoid, at apex with long (5-28 μm), cylindrical projection, thin-walled, hyaline, plasmatic pigment absent. PLEUROCYSTIDIA 60-100 × 10-16 μm, subcylindrical or slender fusoid, thin-walled, hyaline, intermixed (near lamellar edges) with cheilocystidia-like cells, scattered. PILEIPELLIS (sect. *Celluloderma*,



Figs.1-6: *Pluteus neotropicalis* (Holotype), 1: basidiospores (x 2000), 2: basidia (x 1000), 3: cheilocystidia (x 1000), 4: pleurocystidia (x 1000), 5: caulocystidia (x 500), 6: pileipellis (x 500).

subsect. *Mixtini*) a celluloderm, composed of vesiculose, clavate, cylindrical or broadly fusoid cells, 25-60 × 6-20 µm, intermixed with slender fusoid, thin-walled, hyaline pileocystidia (60-100 × 10-15 µm). Oleiferous hyphae absent. CAULOCYSTIDIA (15-) 20-61 (-67.5) × (6-) 8-15 µm, shape like cheilocystidia, rarely subfusoid, thin-walled, hyaline, numerous. Clamp connections absent.

HABITAT – Lignicolous, gregarious, in tropical evergreen forests and subtropical montane cloud forests.

> MATERIAL EXAMINED – MEXICO: **Colima**: Municipality of Ixtlahuacán, 5 km near to Agua de la Virgen towards the town 26 de Julio, alt. 590 m, 26.IX.1996, *O. Rodríguez 1107* (paratype IBUG). - **Quintana Roo**: Municipality of Felipe Carrillo Puerto, Zona de Chunyaxché, near to road Puerto Morelos to Carrillo Puerto, 4.XI.1981, *G. Guzmán 20634* (paratype ENCB); *G. Guzmán 20644* (holotype XAL, isotypes ENCB, IBUG, ZT). - **Veracruz**: old road Xalapa to Coatepec, near to km 6, Municipality of Coatepec, Congregación Zoncuantla, alt. 1270 m, Dr. Gastón Guzmán's house, 14.IX.1994, *G. Guzmán 30963* (paratype XAL); 1.XII.1998, *G. Guzmán 32758* (paratype XAL).
>
> ADDITIONAL MATERIALS EXAMINED REFERRING TO *PLUTEUS THOMSONII* - ENGLAND: West Farleigh, near Maidstone (ex herb. M. J. Berkeley, K-93764, holotype). - SPAIN: Prov. Madrid, El Plantío La Florida, 2.X.1975, *M. Piera s.n.* (AH-945). - SWITZERLAND: Kerns OW (Kernwald), quadrant 1966, alt. 600 m, 17.VIII.1992, *FK-1708-92 K1* (NMLU).

OBSERVATIONS - *Pluteus neotropicalis* is distinguished by the size and shape of the cheilocystidia, the pileipellis structure, and habitat. Due to the lacunose-venose, grayish-brown pileus, the most closely related species based on morphology is *P. thomsonii* (Berk. & Broome) Dennis, which is reported from Europe, North America and North Africa (Citérin & Eyssartier 1998) and cited as restricted to temperate habitats (Orton 1986, Vellinga 1990).

Erroneously, Rodríguez & Guzmán-Dávalos (1999) previously referred collection Rodríguez1107 from Mexico to *P. thomsonii*. However, our subsequent comparison of additional Mexican material and European *P. thomsonii* collections reveal that in *P. thomsonii* the cheilocystidia have longer (≤ 50 µm) acute apices. The type of *Pluteus thomsonii* is in fragmentary condition; only basidiospore size and shape could be confirmed, as all other micromorphological structures had collapsed. Based on their description of the tropical habitat and cystidia with short rostrate apices, the report by Wartchow et al. (2004) of *P. thomsonii* from a subtropical rain forest in Brazil should probably be referred to *P. neotropicalis*,.

Pluteus insidiosus Vellinga & Schreurs, described from Europe, is also similar morphologically, but the pileipellis hymeniderm is composed exclusively of claviform or obovoid cells and lacks distinctive pileocystidia (Vellinga & Schreurs 1985, Vellinga 1990, Breitenbach & Kränzlin 1995). A further morphologically related species is *P. diverticulatus* Corriol, also reported from Europe, which can be separated by its diverticulate and polymorphic cheilocystidia, pileipellis structure, and caulocystidial shape (Corriol 2003).

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Literature cited

Bas C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. Persoonia 5: 285-579.

Breitenbach J, Kränzlin F. 1995. Fungi of Switzerland. Vol. 4. Agarics, 2nd part. Mykologia Lucerne, Lucerne.

Candusso M, Gennari A, Ayala N. 1994. *Agaricales* de Baja California-México. Mycotaxon 50: 175–189.

Cifuentes J, Guzmán G. 1981. Descripción y distribución de hongos tropicales (*Agaricales*) no conocidos previamente en México. Bol. Soc. Mex. Mic. 16: 35-61.

Citérin M, Eyssartier G. 1998. Clé analytique du genre *Pluteus* Fr. Docum. Mycol. 28 (111): 47-67.

Corriol G. 2003. *Pluteus diverticulatus* sp. nov., une espèce nouvelle de la Sous-Section *Mixtini*. Bull. Soc. myc. Fr. 119 (3-4): 231-243.

Orton PD. 1986. Pluteaceae: *Pluteus* & *Volvariella*. In: Henderson DM, Orton PD, Watling R (eds.). British Fungus Flora: Agarics and boleti, vol. 4. Royal Botanic Garden, Edinburgh.

Ramírez-Guillén FJ. 1998. Algunos macromicetos de Zoncuantla, Mpio. de Coatepec, Veracruz. Tesis de Licenciatura en Biología. Facultad de Biología, Universidad Veracruzana, Xalapa, Veracruz, México.

Ramírez-Guillén FJ, Guzmán G. 2003. Hongos de Zoncuantla, Veracruz I. Nuevos registros para Veracruz y México. Acta Bot. Mex. 63: 73-82.

Rodríguez O. 2005. Contribución al estudio taxonómico del género *Pluteus* Fr. (*Agaricales*) en México. Tesis de doctorado. Facultad de Biología, Departamento de Biología Vegetal, Universidad de Alcalá. Alcalá (Madrid), España, 182 pp.

Rodríguez O, Guzmán-Dávalos L. 1997. New additions to the genus *Pluteus* (*Pluteaceae, Agaricales*) for Mexico. Micol. Neotrop. Apl. 10: 83-91.

Rodríguez O, Guzmán-Dávalos L. 1999. Nuevos registros del género *Pluteus* (*Pluteaceae*) en México. Documents Mycologiques 29 (114): 67-78.

Rodríguez O, Guzmán-Dávalos L. (1999) 2000. Algunas especies del género *Pluteus* (*Pluteaceae, Agaricales*) en Nueva Galicia, México. Bol. Inst. Bot. 7(1-3): 61-77.

Rodríguez O, Guzmán-Dávalos L. 2001. Clave dicotómica de las especies del género *Pluteus* Fr. (*Pluteaceae*) conocidas de la Nueva Galicia y algunas áreas aledañas, México. Acta Bot. Mex. 57: 23-36.

Rodríguez O, Guzmán-Dávalos L, Vargas O. 1997. New reports of the genus *Pluteus* (*Agaricales*) from Mexico. Mycotaxon 61: 473-480.

Rodríguez O, Moreno G, Heykoop M. 2004. El género *Pluteus* en México, diagnosis latinas y comentarios taxonómicos, corológicos y ecológicos. Bol. Soc. Mic. Madrid 28: 291-314.

Singer R. 1973. Diagnoses fungorum novarum Agaricalium. III. Beih. Sydowia 7: 1-106.

Vellinga EC. 1990. *Pluteaceae*. - In: Bas C, Kuyper TH, Noordeloos ME, Vellinga EC (eds.). Flora Agaricina Neerlandica. Balkema, Rotterdam.

Vellinga EC. 1998. Glossary. - In: Bas C, Kuyper TH, Noordeloos ME, Vellinga EC (eds.). Flora Agaricina Neerlandica. Balkema, Rotterdam.

Vellinga EC, Schreurs J. 1985. Notulae ad floram agaricinam Neerlandicam. 8. *Pluteus* Fr. in West-Europe. Persoonia 12: 337-373.

Wartchow F, Cortez VG, Coelho G. (2004). *Pluteus thomsonii* (*Pluteaceae*): a northern agaric found in South America. Mycotaxon 89: 349-353.

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Basidiopycnides albertensis gen. et sp. nov., a new anamorphic fungus with phylogenetic affinities in the *Atractiellales (Basidiomycota)*

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Abstract — A new anamorphic genus, *Basidiopycnides*, and its type species, *Basidiopycnides albertensis*, are described. Strains of *Basidiopycnides albertensis* produce what superficially appeared to be a *Graphium*-like conidial state with percurrently proliferating annellophores. Detailed morphological and molecular data analysis showed these isolates represent a new taxon that belongs to the *Atractiellales (Basidiomycota).*

Key words — bark beetles, DAPI staining, molecular phylogeny

Introduction

In 1987 collections of bark beetle infested material from various coniferous hosts yielded isolates resembling synnematous species of either *Graphium* Corda or *Pesotum* J.L. Crane & Schokn. But since then, species of these and other similar genera have been studied extensively. Seifert & Okada (1993) proposed that *Graphilbum* H.P. Upadhyay & W.B. Kendr., *Pesotum*, *Hyalopesotum* H.P. Upadhyay & W.B. Kendr., *Phialographium* H.P. Upadhyay & W.B. Kendr., *Pachnodium* H.P. Upadhyay & W.B. Kendr., and *Graphiocladiella* H.P. Upadhyay were all synonymous with *Graphium*. However, later detailed morphological and molecular taxonomic studies showed that *Graphium* and *Pesotum* are distinct (Okada et al. 1998b, 2000), and that while *Graphium* species are linked phylogenetically to the *Microascales*, *Pesotum* species are linked to the *Ophiostomales* (Okada et al. 1998b, 2000; Jacobs et al. 2003). Therefore, *Ophiostoma* anamorphs formerly placed in *Graphilbum*, *Hyalopesotum*, *Phialographium*, *Pachnodium*, and *Graphiocladiella* now should be treated under *Pesotum* J.L. Crane & Schokn. emend. G. Okada & Seifert (Okada et al. 1998b, p. 1503; 2000).

Although two variants of percurrently proliferated conidiogenous cells were recognized in *Graphium* species (Seifert & Okada 1993, Okada et al. 1998b, 2000), both are said to be enteroblastic annellidic: one form produces nodular annellations; the second a mixture of nodular and dense annellations. In contrast conidiogenesis in *Pesotum* is either holoblastic or enteroblastic phialidic (Okada et al. 1998b).

Five cultures isolated from material collected in Banff National Park, Alberta, Canada, exhibited serial percurrent formation and secession of holoblastic conidia that resulted in the formation of proliferated annellophores sensu Kiffer & Morelet (2000), with elongate intervals between the successive annellations that mark spore-production sites. However, the nodular annellations seen in some *Graphium* species were absent. The conidia ultimately aggregated into slimy masses, but the conidiophores were neither verticillate nor penicillate. Their macronematous conidiomata also differed markedly from synnemata produced by *Pesotum* and *Graphium* species, in that they developed from simple erect hyphal initials that produced basally constricted branches from just below the septa. These branches curved sharply upward immediately after initiation, and grew parallel to the parent element; each branch produced several new branches in a similar manner. At the apices of the ultimate branches, the annellophores were formed. There was a wide range of sizes noted amongst the conidiophores observed, and when conidiomata coalesced laterally, top-shaped structures were formed with globules of conidia at their apices. This developmental pattern is different from those of synnemata as described by Seifert (1985) and Seifert & Okada (1990).

As the conidiogenesis and conidiophore branching of our strains were similar to certain basidiomycete species, e.g., *Stilbotulasnella conidiophora* Bandoni & Oberw. (1982), *Gloeosynnema ochroleucum* (Penz. & Sacc.) Seifert & G. Okada (1988), *Gloeosynnema roseum* Matsush. (1995), *Filosporella annelidica* (Shearer & J.L. Crane) J.L. Crane & Shearer (1977), and species of the ascomycete genus *Pyxidiophora* Bref. & Tavel (Blackwell & Malloch 1989), we used sequence analyses of the 18S ribosomal RNA gene (18S rDNA) and rDNA internal transcribed sequences (ITS), and incident-light fluorescence microscopy to determine their phylogenetic relationship and nuclear status.

Materials and methods

Strains studied and morphology. Five isolates, whose collection details are given under the new species description, were obtained from host material from which beetles had been removed at the collection site according to

Hutchison & Reid (1988) and Eyjólfsdóttir (1990). These have been maintained at 4 °C in darkness on slants of malt extract agar (Difco, MI; Fisher Scientific Fair Lawn, NJ) plus yeast extract (MEYE, Hausner et al. 2003) and culture descriptions on agar were also prepared according to Hausner et al. (2003). Isolates were also grown on autoclaved *Pinus mugo* Turra and *Pinus sylvestris* L. twigs embedded aseptically in both 2.0 % water agar or MEYE in Petri dishes at 20 °C to see if different forms of fruiting occurred. The twig culture technique was repeated with our strains using three separate sets of twig-plates inoculated in combination with one of three strains of *Clonostachys rosea* (Link) Schroers et al. (1999); the latter had successfully induced perithecial formation in strains of *Ceratocystiopsis falcata* (E.F.Wright & Cain) H.P. Upadhyay [≡ *Cornuvesica falcata* (E.F. Wright & Cain) Viljoen et al.] (Hutchison & Reid 1988, Kawchuk et al. 1993). Inoculated twig plates lacking the *Clonostachys* strains served as controls. Portions of both living and dried specimens have been deposited in the University of Alberta Microfungus Collection and Herbarium (UAMH), Devonian Botanic Garden, and are also held in the Biological Sciences Department [WIN(M)] of the University of Manitoba.

Morphological structures used to identify isolates were mounted on slides in either 85 % lactic acid or 85 % lactic acid/water solutions (1:15 by volume), and cover slips were ringed with nail varnish prior to observation. But the pure 85 % lactic acid mounts were placed on a slide warmer at 40 °C for 24 hours before ringing, while the lactic acid/water mounts were ringed and studied immediately; the latter yielded clearer preparations (Eyjólfsdóttir 1990). At least 50 measurements of spores were recorded for statistical analysis, and either a Leitz Ortholux II or a Zeiss Photomicroscope II was used for observations, drawings and photography. We used Munsell Soil Color charts (Kolmorgen Corp., Baltimore, MD) to categorize for colours, and Gams (1971) for descriptions of colony texture and conidiophore organization.

Nuclear staining and incident-light fluorescence microscopy. Aseptically, in a laminar flow chamber, sterile slides were dipped in sterile molten malt extract (2 g malt extract, 20 g agar, 1 l tap water). One side was wiped clean, and the slide placed agar side up on a sterile bent glass rod in a sterile Petri dish moist-chamber lined with several layers of moistened sterile paper toweling. Slides were inoculated aseptically at the centre with a spore mass from a fresh culture of the selected test strain, and the Petri dishes were incubated at 20 °C for 7 days. If at that time growth had occurred, slides were fixed in 100 % methanol and stained with DAPI (4', 6-diamadino-2-phenylindole) according to Hamada & Fujita (1983) as described by Okada et al. (1998a). But we replaced the 2-mercapto-ethylamine in the staining solution with 2-mercaptoethanol (Aldrich Chemicals, Milwaukee, WI); the latter had been shown to be highly effective in fungi (M. Young, personal communication).

When maintained on ice in a refrigerator at 4 °C, these slides yielded good results for up to 5 days after preparation. The nuclei were visualised using a Zeiss Axio Imager and the images collected digitally with an AxioCam Mrm camera.

DNA extraction and amplification protocols. DNA extraction, purification, and agarose electrophoresis protocols were those of Hausner et al. (1992). Whole cell DNA served as the template for amplifying DNA fragments of interest using the Invitrogen-BRL PCR System (Buffer and Taq polymerase, Invitrogen, Fredrick, MD). Primers SSUZ and LSU4 (Hausner et al. 2005) were used to amplify the ITS regions, and primers SSJ and SST were employed to recover the 18S rDNA. The PCR primer sequences, amplification conditions, sizes of the expected PCR products, and preparation of sequencing templates for ITS, and 18S rDNA fragments have been described previously (Hausner & Reid 2004, Hausner & Wang 2005, Hausner et al. 2005). DNA sequencing templates were prepared with the aid of the Promega Wizard SV Gel and PCR clean-up system (Promega, Madison, WI). Purified double-stranded PCR products were sequenced in both directions using the cycle-sequencing protocols performed according to the manufacturers' recommendations (Perkin Elmer Applied Biosystems, Foster City, CA), and automated Fluorescent DNA sequence analysis was performed using an ABI Prism 310 Genetic Analyzer system (PEAB at the University of Calgary, DNA sequencing facility, Calgary, AB).

Analyses of DNA sequence data. Forty-seven 18S rDNA sequences were aligned with CLUSTAL-X (Thomson et al. 1997) and, when appropriate, modified with the alignment editor program GeneDoc v2.5.010 (Nicholas et al. 1997, http://www.psc.edu/biomed/genedoc). The alignment (EMBL-Align database accession: ALIGN_001145) covered 1742 positions and the 18S rDNA sequence of *Saccharomyces cerevisiae* Meyen ex E.C. Hansen var. *cerevisiae* served as the outgroup in phylogenetic analysis. First, programs contained within PHYLIP (Felsenstein 2006, Version 3.66; http://evolution.genetics.washington.edu/phylip/getme.html) were used to resolve phylogenetic relationships among the tested sequences, and the data set was then analyzed with DNAPARS (maximum parsimony) and DNADIST (F84 setting). From the latter, the distance matrix generated was utilized in the NEIGHBOR program (NJ setting) for inferring a phylogenetic tree. The phylogenetic estimates were evaluated using the bootstrap procedure (SEQBOOT 1000 replicates; and CONSENSE) in PHYLIP. The 18S rDNA data was also analyzed with the Tree-Puzzle (TP) program [maximum likelihood (ML) phylogenetic analysis using quartets and parallel computing (Schmidt et al. 2002)]. The settings for the quartet puzzling algorithm were as follows: 10000 puzzling steps, transition/transversion parameter estimated from data set, HKY evolutionary model

(Hasegawa et al. 1985). However tree topologies were essentially identical to those of parsimony and NJ analysis. Finally the MrBayes (version 3.1) program (Ronquist & Huelsenbeck 2003; Ronquist 2004) was used for Bayesian analysis. The NEXUS file format necessary for the alignment (input) file was generated with the file converting option available within the DAMBE (Xia 2001). The DNA substitution model setting for Bayesian analysis was: GRT, gamma distribution with 4 gamma rate parameters. The model of DNA substitution was chosen based on evaluating the 18S rDNA alignment with the Modeltest 3.0 program (Posada & Crandall 1998). The Bayesian inference of phylogenies was initiated from a random starting tree, and four chains were run simultaneously for 250000 generations; trees were sampled every 100 generations. The first 25 % of trees generated were discarded ("burn-in") and the remaining trees were used to construct both a 50 % majority rule consensus tree and compute the posterior probability values.

Results

Our fungus morphologically resembled anamorphs of both some ascomycetous and basidiomycetous taxa, but the nuclear staining and fluorescent microscopy clearly showed that individual hyphal cells, conidiogenous cells, and conidia were very rarely other than binucleate (see under Taxonomy). This dikaryotic condition suggests these isolates are the anamorph of a basidiomycete.

This staining technique produced surprisingly good nuclear staining and, unexpectedly, it also showed the proliferated annellophores extremely well.

To investigate the molecular phylogeny of our fungus, the 18S rDNA sequences were determined for two of our isolates [UAMH 10782 and 10785], these were identical (GenBank EF406118), and were used as queries in a Blastn (Altschul et al. 1997) NCBI database search. The results showed they were closely related to the holotypes of *Basidiopycnis hyalina* Oberw. et al. and *Proceropycnis pinicola* M. (Oberwinkler et al. 2006), both monotypic genera. At least partially by comparing 18S rDNA sequences of their two new species with a variety of basidiomycete sequences, six of which were from species of the *Atractiellales*, they placed their new species within the order *Atractiellales*, class *Atractiellomycetes*, subphylum *Pucciniomycotina*, division *Basidiomycota* (Bauer et al. 2006).

Because our strains closely resembled *Basidiopycnis hyalina* in some features, 18S rDNA sequences of the following species were included in the phylogenetic analysis: *Basidiopycnis hyalina*, *Proceropycnis pinicola, Phleogena faginea* (Fr.) Link, *Helicogloea lagerheimii* Pat., and *Atractiella solani* (Cohn & J. Schröt.) Oberw. & Bandoni (Fig. 1A). Various ascomycete taxa that morphologically resembled our isolates were also included, e.g. *Ophiostoma ulmi* (Buisman) Nannf.(has a *Pesotum* anamorph) and several *Graphium* species. Phylogenetic analysis of the 18S rDNA data using four different (NJ, Parsimony, Bayesian,

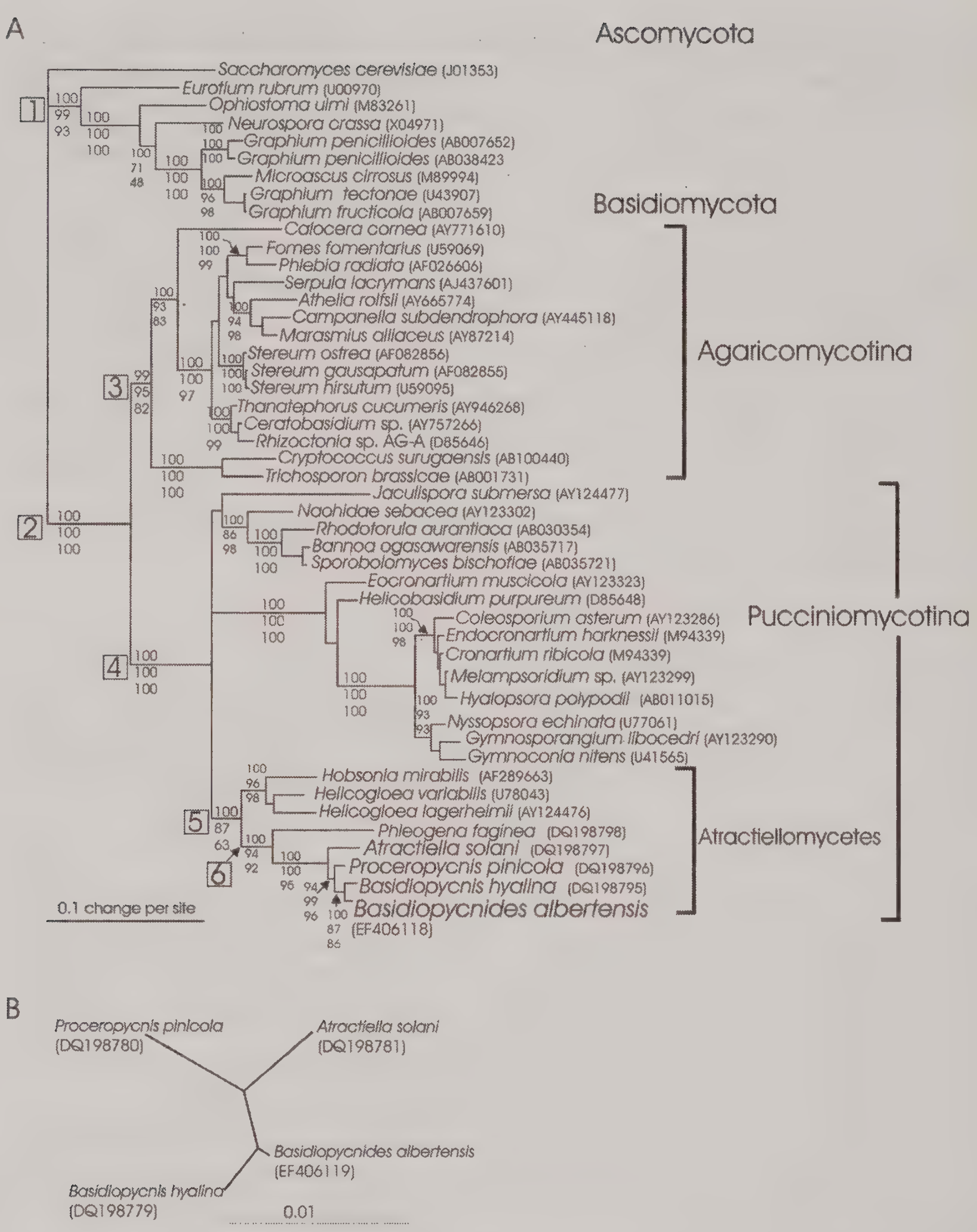
A
Ascomycota
Saccharomyces cerevisiae (J01353)
Eurotium rubrum (U00970)
Ophiostoma ulmi (M83261)
Neurospora crassa (X04971)
Graphium penicillioides (AB007652)
Graphium penicillioides (AB038423)
Microascus cirrosus (M89994)
Graphium tectonae (U43907)
Graphium fructicola (AB007659)
Basidiomycota
Calocera cornea (AY771610)
Fomes fomentarius (U59069)
Phlebia radiata (AF026606)
Serpula lacrymans (AJ437601)
Athelia rolfsii (AY665774)
Campanella subdendrophora (AY445118)
Marasmius alliaceus (AY87214)
Stereum ostrea (AF082856)
Stereum gausapatum (AF082855)
Stereum hirsutum (U59095)
Thanatephorus cucumeris (AY946268)
Ceratobasidium sp. (AY757266)
Rhizoctonia sp. AG-A (D85646)
Cryptococcus surugaensis (AB100440)
Trichosporon brassicae (AB001731)
Agaricomycotina
Jaculispora submersa (AY124477)
Naohidae sebacea (AY123302)
Rhodotorula aurantiaca (AB030354)
Bannoa ogasawarensis (AB035717)
Sporobolomyces bischofiae (AB035721)
Eocronartium muscicola (AY123323)
Helicobasidium purpureum (D85648)
Coleosporium asterum (AY123286)
Endocronartium harknessii (M94339)
Cronartium ribicola (M94339)
Melampsoridium sp. (AY123299)
Hyalopsora polypodii (AB011015)
Nyssopsora echinata (U77061)
Gymnosporangium libocedri (AY123290)
Gymnoconia nitens (U41565)
Pucciniomycotina
Hobsonia mirabilis (AF289663)
Helicogloea variabilis (U78043)
Helicogloea lagerheimii (AY124476)
Phleogena faginea (DQ198798)
Atractiella solani (DQ198797)
Proceropycnis pinicola (DQ198796)
Basidiopycnis hyalina (DQ198795)
Basidiopycnides albertensis (EF406118)
Atractiellomycetes
1
2
3
4
5
6
0.1 change per site
B
Proceropycnis pinicola (DQ198780)
Atractiella solani (DQ198781)
Basidiopycnides albertensis (EF406119)
Basidiopycnis hyalina (DQ198779)
0.01

Fig. 1: Phylogenetic analysis of the 18S rDNA sequence data. A. Phylogenetic tree for *Basidiopycnides albertensis* within the *Atractiellales*. Tree is based on a 50 % majority rule consensus tree obtained from Bayesian inference. The first number at the nodes above the line represents the posterior probability values obtained from Bayesian analysis. The second and third number (below the lines) at the nodes indicate the level of support based on bootstrap analysis (Felsenstein 1985; % based on 1000 bootstrap replicates) in combination with NJ and PARS analysis respectively. The 18S rDNA alignment can be retrieved from the EMBL-Align database under the following accession: ALIGN_001145. B. The unrooted Neighbour-Joining (PHYLIP, NJ, DNADIST: setting K84) phylogenetic network showing the relatedness among partial ITS region sequences for four species of the *Atractiellales* including *Basidiopycnides albertensis.* For those sequences that were obtained from NCBI the GenBank accession numbers are provided for in brackets following the species names. The phylogenetic tree (A) and dendrogram (B) were drawn with the TreeView program (Page 1996) using the PHYLIP tree outfiles, and annotations were added to the figures with the aid of Corel Draw (Corel Corporation and Corel Corporation Limited, Ottawa, Canada).

Maximum-likelihood as implemented in TreePuzzle) methods for inferring evolutionary relationships yielded trees with essentially similar topologies (Fig. 1A).

This 18S rDNA data set also separated members of the *Ascomycota* from those of the *Basidiomycota* and, as expected from previously proposed phylogenies (Sikaroodi et al. 2001, Swann et al. 2001, Bauer et al. 2006, Blackwell et al. 2006), placed members of the *Agaricomycotina* and *Pucciniomycotina* of the *Basidiomycota* into specific clades. The 18S rDNA sequences of UAMH 10782 and 10785 grouped within a clade that included species of the class *Atractiellomycetes* (see Fig 1A, node 5). More precisely, our strains, under the name of *Basidiopycnides albertensis* (see Taxonomy) , were placed within the *Atractiellales* in a monophyletic clade that contains *Basidiopycnis hyalina, Proceropycnis pinicola, A. solani,* and *Phleogena faginea* (Fig. 1A, node 6). Most notably, the18S rDNA sequences of these strains differed by only 3 substitutions from the 18S rDNA sequence of *B. hyalina,* but there were 5 and 6 nucleotide differences between the UAMH strains and the sequences of *A. solani* and *Proceropycnis pinicola*, respectively.

The rDNA ITS regions (ITS1, 5.8S rDNA, ITS2) for all of our five strains (UAMH 10782 to UAMH 10786) were sequenced (GenBank EF406119), and these ITS regions of 551 bp, were identical. Partial ITS region sequences (405 bps) from *Basidiopycnis hyalina* (DQ198779), *P. pinicola* (DQ198780) and *A. solani* (DQ198781) were compared with those of our strains (Fig. 1B) and, excluding gaps, there were 16 nucleotide differences between the ITS sequences of the UAMH strains and that of *B. hyalina*, compared to 46 and 52 nucleotide differences between our strains and the ITS sequences of *P. pinicola* and *A. solani* respectively.

These results show that our isolates are distinct from related species, and we propose a new species in a new anamorphic basidiomycete genus.

Taxonomy

Basidiopycnides J. Reid, Eyjólfsd. & G. Hausner, **gen. nov.**

MycoBank MB510902

Hyphomycetus. Hyphae hyalinae, leaves, septatae sine fibulis, cellulae binucleatae. Conidiophora ab initio ex hypha singulare erecta constantia; postea regulatim multo ramificantia, sic habitu mononemata vel macronemata. Conidiophora singula suis lateribus adhaerescentia, habitu saepe turbinata. Cellula conidiogena terminalis, annellophorum percurrens, primo ad apicem conidium singulare formans posteaque, primum conidium secessum, successive conidia additicia holoblastica formans. Conidia in guttas mucosas aggregata, unicellularia, hyalina, laevigata; oblonga vel breviter clavata apicibus obtusis, sed basibus truncatis cum fimbriis curtis basilaribus. Conidia plerumque tempore germinationis nova annellophora emittunt.

Etymology: From the generic name *Basidiopycnis*, and -ides (Latin, = like, connected with)

Type species:

Basidiopycnides albertensis J. Reid, Eyjólfsd. & G. Hausner, **sp. nov.**

MycoBank MB 510903 Figs. 2 - 6.

Hyphomycetus. Coloniae in agaro cum extracto malti fermentique ad 20 °C aut 16-32 mm diametro post 12 dies aut 26-80 mm post 21 dies in obscuritate, aut 13-17 mm post 12 dies in luce obscuritateque alternanti; albae vel dilutissime brunneae; demum crassis muscosis massis conidiorum obtectae. Hyphae 1.5-3.0 μm diametro, hyalinae, laeves sine fibulis. Cellulae binucleatae. Conidiophora 220-400 μm longa, mononemata vel macronemata. Rami proxime infra septa orientes, saepe in origine attenuati, autem cito sursum curvati dilatatique. Cellulae conidiogenae terminales, holoblasticae, cylindricae vel basi leniter contractae, annellophorae percurrens 25-90 (100) x 2.5-3.4 (4.0) μm. Situs conidiogeni successivi 0.5-7.0 μm distantes. Conidia 6.5-16(-18.5)(sd=11.45 ± 2.78) X 2.5-4.0 (-4.5)(sd=3.45 ± 0.65) μm in guttas mucosas aggregata, unicellularia, hyalina, laevigata, oblonga vel breviter clavata; basibus truncatis cum fimbriis; per hyphas vel annellophora secundaria germinantia.

Holotype: Canada, Alberta; Taylor Lake Hiking Trail, Banff National Park. Dried colonies on sterile pine twigs embedded in malt extract/yeast extract agar (MEYE) isolated from bark beetle galleries in *Pinus contorta* var. *latifolia* Engelm. bark, collected 23 September 1987, J. and B. Reid, derived from UAMH 10782.

Isotype: WIN(M)1397

Etymology: From the provincial name, Alberta.

Colonies on MEYE white to very pale brown (10YR8/2 to 8/3) with even margins in alternating light and dark at 20 °C, margins white (10YR8/2) to translucent. Dark grown colony margins often irregular due to faster growing hyphae developing short, lateral dendroid branches around the margins, but these are less pronounced in alternating light. White (10YR8/2) beneath areas of denser mycelium, but colourless elsewhere. Odour lacking or indistinct. Attaining 16-32 mm diam in 12 days or 26-80 mm in 21days in darkness, and 13-17 mm in 12 days in alternating light and dark, all at 20 °C. Hyphae hyaline, smooth-walled, 1.5-3.6 μm wide, cells binucleate, aerial hyphae collapsing in older cultures. Clamps and chlamydospores lacking. Conidiophores erect, initially arising from single hyphal elements, phalacrogenous, mononematous, semi-macronematous or macronemetous, the latter often coalescent laterally and then resembling top-shaped conidiomata with glistening apices (Figs. 2,3).

Macronematous conidiophores 220-400 μm long, with each branch narrowed at its point of emergence from immediately below a septum in the originating hypha, curving upward sharply and widening to normal size; the vast majority have a basal septum above the curve, and all are terminated by percurrently proliferating annellophores (Figs. 3,4,5); producing slimy conidial masses; medium-embedded hyphae may produce crescent-shaped conidial masses. Conidiogenous cells holoblastic, terminal, integrated, percurrent, forming conspicuous annellophores 25-150 X 2.5-3.5 (-4.0) μm; these are at

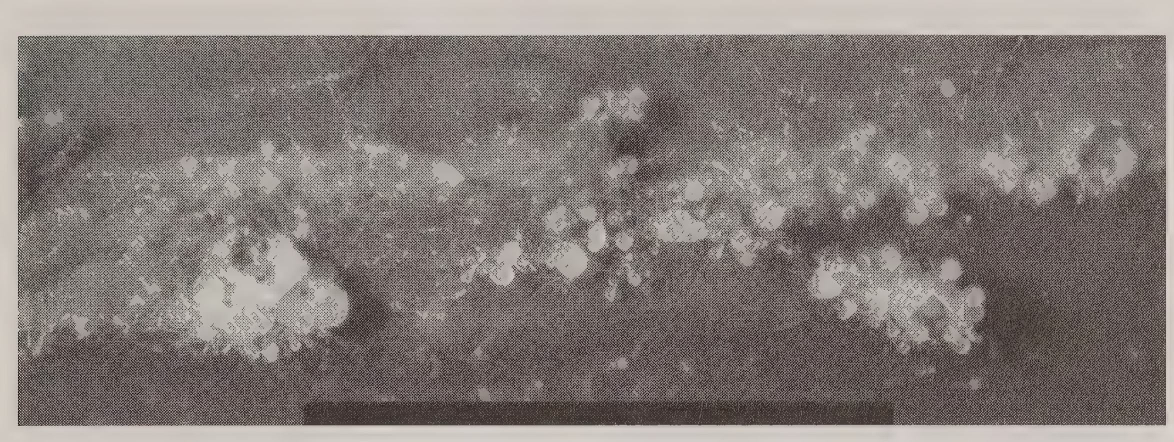

Fig. 2: Conidiomata of *Basidiopycnides albertensis* (strain: UAMH 10784 = WIN(M) 720) in various stages of development, growing on an autoclaved pine twig in agar. Bar = 10 mm.

first parallel-sided but taper gradually towards the apex, and are occasionally either slightly constricted or form slightly swollen nodular annellations at their base. ANNELLATIONS occur at intervals of 0.5-7.0 µm, with the longer intervals formed first. CONIDIA (Figs. 3,6) unicellular, hyaline, binucleate, smooth-walled, oblong to occasionally short clavate, with an obtuse apex and truncate base that may be slightly narrowed, but with a short but definite frill, 6.5-16(-18.5) (sd=11.45 ± 2.78) X 2.5-4.0(-4.5) (sd=3.45 ±0.65) µm, narrowed bases 2.5 ± 0.8 µm, produced singly, but aggregating in slimy masses in culture, germinating by germ tubes or directly produced annellophores.

TELEOMORPH: Not observed.

ADDITIONAL ISOLATES EXAMINED (PARATYPES). Same site and same date as the holotype: UAMH 10783 = WIN(M) 719 from the same tree as holotype; UAMH 10784 = WIN(M) 720, UAMH 10785 = WIN(M) 1399, and UAMH 10786 = WIN(M) 1425 were from three different trees.

Individual dark grown isolates varied slightly in growth rates and colony morphologies, but in alternating light and dark growth they were very similar. And in all cases secondary conidium production greatly increased the size of the slimy conidial masses on the surface of a colony. Importantly, the nature of the conidiomata formed in twig cultures was the same as on agar plates, e.g., size variation, branching pattern, conidium size, etc.

Occasionally conidia remain attached at the conidiogenous locus; this caused bending in the annellation zone (Fig. 3). However, this is different from the situation where seceded conidia sometimes remain adherent after secession; presumably because of the presence of mucilaginous material on either walls of the conidia or conidiogenous cell. When viewed with phase contrast optics, both conidium initials and most conidia have a halo surrounding them (Fig. 6); that may be a mucilaginous sheath.

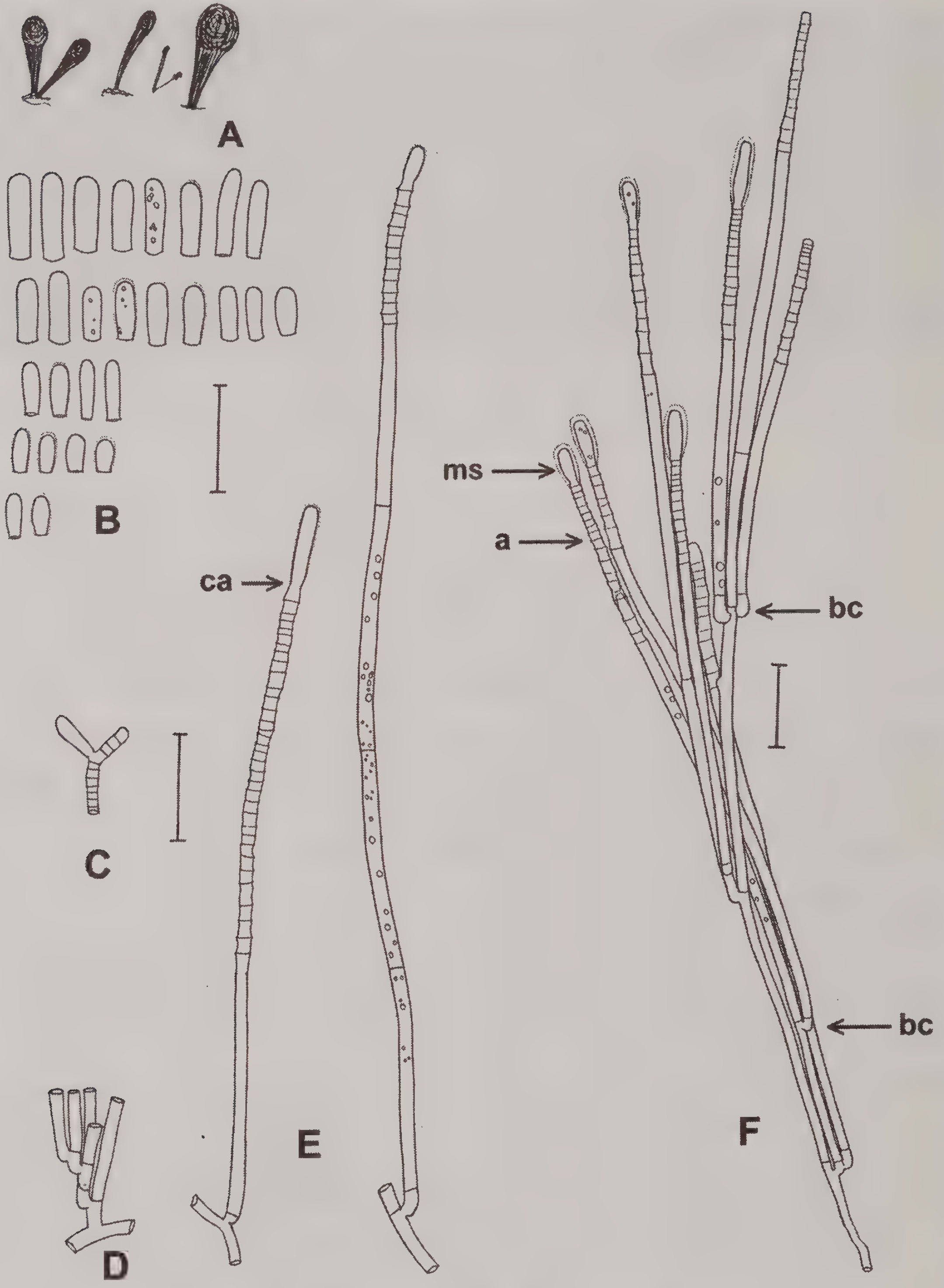

Fig. 3: Line drawings of *Basidiopycnides albertensis* (strain: UAMH 10786 = WIN(M) 1397). A. Habit sketch of individual conidiophores aggregations; not to scale. B. Conidial size variation. Some conidia have guttules and / or sheaths. Bar = 20 µm. C. An annellation zone from which a conidium was displaced in a sympodular manner. D. Basal branching of a complex conidiophore. E. Two mononematous conidiophores (annellophores), one highly guttulate. When a conidium is formed initially, it is often subtended by a slight constriction in the originating conidiogenous cells (ca). Bar for C, D, and E = 20 µm. F. Young conidioma with branched conidiophores arising from a single element; conidium with mucilaginous sheath (ms); annellation (a); branch constriction (bc). Bar = 20 µm.

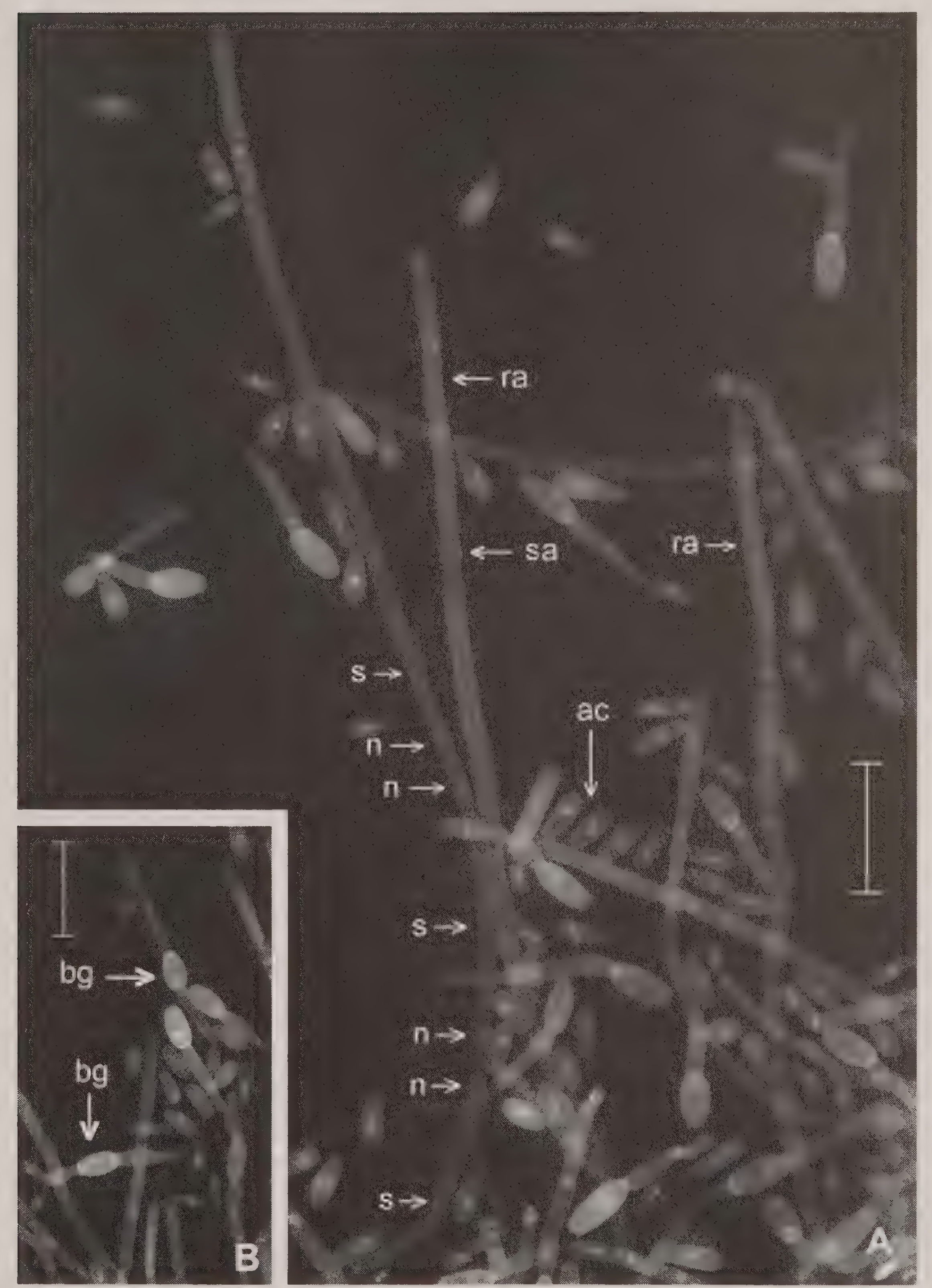

Fig. 4: An incident-light fluorescent micrograph of a DAPI-stained slide culture (strain: UAMH 10784 = WIN(M) 720]. A. Binucleate hyphal cells; septa (s) and nuclei (n). Swellings on the annellophore base (sa). Laterally displaced seceded conidia (ac) still adhering to a proliferated annellophore. Repetitively produced annellations (ra). Bar = 20 µm. B. Two bipolar germinating conidia (bg). Bar = 20 µm. In both A and B, the conidia are regularly binucleate and, on germinating, successive conidiogenous sites are often narrower.

Discussion

None of the strains of *Basidiopycnides albertensis* ever produced basidiomata in culture, and their conidiomata superficially resemble synnemata as characterized by Seifert (1985) and Seifert & Okada (1990). However, our DAPI nuclear staining results that showed the hyphal cells and the conidia are consistently binucleate, and the DNA sequence phylogeny data combined, provide strong evidence that this species is a member of the Basidiomycota closely allied to, but not identical with, *Basidiopycnis hyalina* of the *Atractiellales*. And while morphological similarities were evident in these two species, e.g., the manner of conidiophore branching, size and shape of conidia and the latter's aggregation into slimy masses. Neither significant annellations nor pronounced annellation intervals were described or figured for *Basidiopycnis hyalina* – herein we use annellation to denote the sites where single conidia are produced, and annellation interval(s) the distance(s) between two such successive sites – but it was said to produce annellides.

In some features *Basidiopycnides albertensis* also resembles the basidiomycete *Stilbotulasnella conidiophora*. However, Bandoni & Oberwinkler (1982) state the annellations in *S. conidiophora* are inconspicuous and only clearly visible when stained, but its annellation intervals as figured are significant. In *Basidiopycnides albertensis* the annellations are seen easily in both water or KOH mounts (Fig. 5). Thus we assume that significant annellation intervals are lacking in *Basidiopycnis hyalina*, since Bandoni & Oberwinkler (1982) illustrated such for *S. conidiophora* where visualization was markedly improved in stained mounts, while Oberwinkler et al. (2006) who also used stained preparations did not record these features in *Basidiopycnis hyalina*. Nor did they record conidial germination by direct production of annellophores in *Basidiopycnis hyalina* as we found in *Basidiopycnides albertensis*; they only reported germination by production of hyphae. Indeed, the conidia of *Basidiopycnides albertensis* typically germinate by the production of either uni- or bipolar secondary annellophores. These can, and do, produce multiple secondary conidia (Figs. 4A, B). Finally, *Basidiopycnides albertensis* is only known from a single location from several *Pinus contorta* var. *latifolia* trees at a single location, while *Basidiopycnis hyalina* occurs in galleries of multiple species of bark-beetles infesting both *Picea abies* (L.) H. Karst. and *Pinus sylvestris* in Germany, Italy and Switzerland (Oberwinkler et al. 2006).

The unusually percurrently proliferating annellophores produced by *Basidiopycnides albertensis* are not unique. Similar annellophores that develop as extensions of conidiophores and conidiophore branches are reported in *Filosporella* [= *Rogersia annelidica* Shearer & J.L. Crane (1976)], but this has very different conidia. Blackwell & Malloch (1989) described the hyaline imperfect state of a *Pyxidiophora* sp. as having 200-300 μm long conidiophores

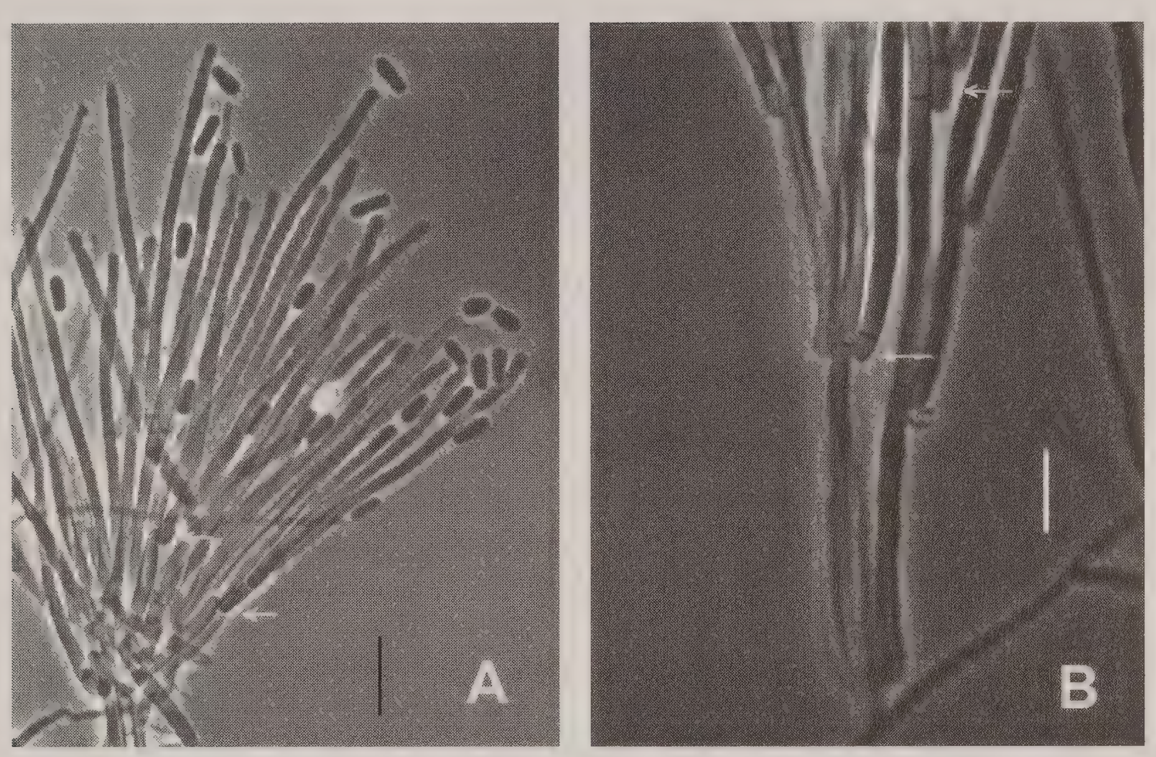

Fig. 5: Phase contrast micrographs of conidiomata (strain UAMH 10786 = WIN(M) 1397). A. An apparent aggregation of at least three conidiomata arising from at least three separate hyphal elements (see base). Note the constricted branch bases (arrows), and the very regular intervals between successive annellations, Bar = 20 µm. B. The base of a conidioma arising from a parent hyphal element shown in two different focal planes. The constricted bases of branching elements can be clearly seen, even in successive branches (arrows). Note on the right the "three level branching pattern of the conidiophore" sensu Jacobs et al. (2003, Fig 12); on the left the conidioma is derived from a single branch arising from a vegetative hyphal element, Bar = 10 µm.

and percurrently proliferating conidiogenous cells; this too was ruled out after examination of a prepared slide loaned by Dr. Malloch. Indeed, such annellophores have been reported in a wide variety of fungi (Glawe 1989), sometimes being produced concurrently with sympodially proliferated conidiogenous cells e.g. in *Diatrype albopruinosa* (Schwein.) Cooke (Glawe & Rogers 1982).

Basidiopycnides albertensis strains resemble superficially species of *Graphium* and *Pesotum* (Seifert & Okada 1993, Okada et al. 1998b) but differ in the branching nature in the conidiomata of *Basidiopycnides albertensis*; lengths of both annellophores and conidiation site intervals; the presence of only slight swelling of some of the basal annellation intervals in the annellophores (Fig. 5), rather than the significant nodulation found in *Graphium* spp.; and the conidiogenous cells that are markedly different to those found in *Pesotum* spp. But the basal branching in *Basidiopycnides albertensis* is strikingly similar to the "Three-level branching pattern of the conidiophore" that illustrates how conidiophores are produced in the capitulum of *Graphium laricis* K. Jacobs et

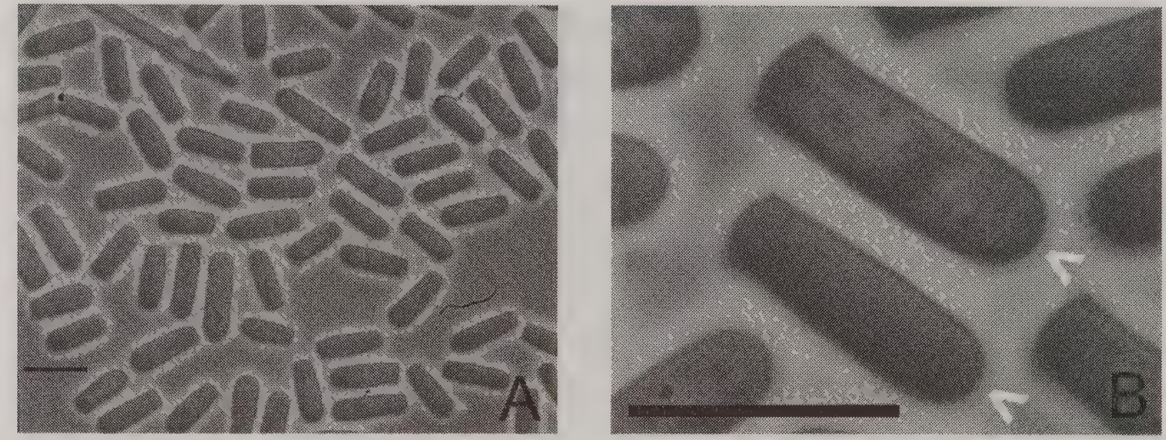

Fig. 6: Phase contrast micrographs of conidia (strain UAMH 10786 = WIN(M)1397). A. Oblong conidia with truncated basal frill [compare with Jacobs et al. 2003, Fig 10], Bar = 10 µm. B. Conidia. The presumed sheath is indicated by arrows. Bar = 10 µm.

al. (2003, Fig. 12), except in the latter the branches do not have constricted bases at their points of origin.

When first reported in the literature (Bauer et al. 2006, pp. 43, 57-58, Fig. 1), *Basidiopycnis hyalina* was treated as one of two new *Atractiellomycetes* with "pycnidial basidiocarps", and only designated by a herbarium number in the discussion in that paper. Later, only *Basidiopycnis hyalina* was confirmed to produce a "pycnidial basidiocarp", i.e., a structure resembling a pycnidium in which basidia and basidiospores are produced; the second species, *Proceropycnis pinicola*, was treated as a new anamorphic fungus (Oberwinkler et al. 2006). However, the latter authors reported that the basidiomata of *Basidiopycnis hyalina* were only produced when strains were paired with other fungi, but not in collections from host material.

We never found basidiomata of *Basidiopycnides albertensis* either on host material or under any culture conditions.

Oberwinkler et al. (2006, p. 644) did not propose an anamorph genus for their asexual phase of *Basidiopycnis hyalina*, stating "We were not able to find morphological characteristics sufficient for separating these basidiomycetes anamorphs on a generic level and, therefore, do not propose a new genus for the anamorph of *B. hyalina*." In support of this they refer specifically to *Stilbotulasnella* Oberw. & Bandoni, a monotypic genus based on *S. conidiophora*, and two species of *Pistillaria* Fr. (Koski & Perrin 1971); the latter two are now considered species of *Typhula*: *T. micans* (Pers.) Berthier and *T. setipes* (Grev.) Berthier (Berthier, 1976). But an anamorph genus is required because criteria other than conidiomatal structure separate organisms such as *S. conidiophora* and *T. micans* from *B. hyalina*. For example, *Basidiopycnis hyalina* has simple septate pores surrounded by atractosomes (Oberwinkler et al. 2006), while *S. conidiophora* has dolipore septa, lacking parenthosomes. We did not examine pore structure in *Basidiopycnides albertensis*. And both *T. setipes* and *T. micans* have clamp connections (Koski & Perrin 1971), but *Basidiopycnis hyalina* (Oberwinkler et al. 2006), *S. conidiophora* and *Basidiopycnides albertensis* do not.

These factors, plus the fact that *Basidiopycnides albertensis* did not produce a teleomorph state, made it difficult to determine the various relationships. But it suggests strongly that relationships should not be assumed based simply on the production of presumptive "enteroblastic annelloconidia". It is doubtful *Graphium* spp. sensu Okada et al. (2000) are closely related to the organisms discussed above, but the method of conidial production in species such as *Graphium laricis* (Jacobs et al. 2003), *Graphium penicillioides* Corda (Okada et al. 2000) or *Remersonia thermophila* (Fergus) Seifert & Samson (Seifert et al. 1997) are superficially strikingly similar to that of *Basidiopycnis hyalina*, *Basidiopycnides albertensis* and *S. conidiophora*. It is also highly unlikely that *Graphium* spp. consistently produce binucleate conidia as observed in *Basidiopycnides albertensis*. Probably, the superficial similarity in conidiogenesis observed in the genera/species listed above simply reflects convergent evolution of a similar, but not identical, characteristic that has been selected for in different groups of unrelated fungi. The production of large masses of sticky spores on upward pointing conidiophores would facilitate their being brushed onto the bodies of insects, and thus favor their dissemination by insects. With the inclusion of sequence data along with morphological criteria, *Basidiopycnides albertensis* can be distinguished from "*Graphium*-like" anamorphs that evolved within both ascomycetous and basidiomycetous lineages. In order to facilitate a better understanding of the biology of these organisms we need to designate a phylogenetic classification. It is likely that more "*Graphium*-like" fungi will be recovered from bark beetle galleries and these organisms should be placed into appropriate genera.

Throughout we have used the term annellophore in reference to conidiogenesis in *Basidiopycnides albertensis*, but this is contrary to the recommendation by Kendrick (1971, p. 261) that the term annellophore should be replaced with annellide to mean annellated conidiogenous cell. However, annellated was defined in that same Proceedings chapter (Kendrick 1971, p. 254) as "condition of a conidiogenous cell which has undergone a number of **very short** percurrent vegetative proliferations, each of which terminated in the production of a single holoblastic conidium. Each --- a **narrow band** of wall material encircling the conidiogenous cell, is called an annellation." (The bold usage is ours). Although subsequently many mycologists have followed this recommendation, we do not feel the term annellide, as defined above, is appropriate for the conidiogenous structure seen in *Basidiopycnides albertensis*. And problems with this general usage of the term annellide have been noted before.

Hammill (1972), in one of a series of papers on conidiogenesis in fungi based on transmission electron microscopy studies, drew attention to an unusual form of such in *Monotosporella sphaerocephala* (Berk. & Broome) S. Hughes [≡ *Acrogenospora sphaerocephala* (Berk. & Broome) M.B. Ellis (1971)]. Here, the subsequent unusual pattern of conidium maturation aside, initial development involved percurrent growth of intraconidiophore hyphae through a previously formed conidium-delimiting septum.

Cole & Samson (1979) using scanning electron microscopy confirmed, and expanded on, Hammill's work and concluded, page 78, "--- it is probable that several genera of annellated Deuteromycetes develop in this manner". But what is significant, from our point of view, is that the annellations on the conidiophore are produced at significant intervals, not very short percurrent vegetative proliferations (see above).

The term annellide was defined by Sutton (1980, p. 642) as "a holoblastic percurrently proliferating conidiogenous cell", a more succinct but nonetheless accurate rendering of Kendrick's (1971, p. 258) definition. And an example of the confusion that existed at that time is to be seen in Bandoni & Oberwinkler (1982, p. 1879) who were unsure as to the true nature of the conidiogenous cells in *S. conidiophora* and wrote "Although we have used the term annellide in reference to the conidiogenous cells, it remains to be demonstrated they are homologs of structures so designated in ascomycetes and hyphomycetes". Then, in a progressive step, Sutton and his colleagues (Minter et al. 1983, pp. 117-118) argued that at least two sets of developmental processes were being defined by the term annellide. This view was supported by both Wang (1990) and Kiffer & Morelet (2000), who both resurrected and defined their concept of an annellophore and redefined an annellide. We concur an annellophore is really an annellated conidiophore; see Wang (1990, pp. 53-56) for a precise description of the postulated process, and that annellophore is the appropriate term to describe conidiogenesis in *Basidiopycnides albertensis*, and quite possibly fungi such as *S. conidiophora* as well. It is probable that transmission electron microscopic pictures will show that the two latter species develop annellophores in a manner consistent with Wang's (1990) theory and, as a consequence, the term annellophore should be reinstated.

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Literature cited

Altschul SF, Madden TL, Schäffer AA, Zhang J, Zhang Z, Miller W, Lipman DJ. 1997. Gapped BLAST and PSI-BLAST: A new generation of protein database search programs. Nucleic Acids Research 25: 3389-3402.

Bandoni RJ, Oberwinkler F. 1982. *Stilbotulasnella*: A new genus in the *Tulasnellaceae*. Canadian Journal of Botany 60: 1875-1879.

Bauer R, Begerow D, Sampaio JS, Weiß M, Oberwinkler F. 2006. The simple-septate basidiomycetes: a synopsis. Mycological Progress 5: 41-66.

Berthier J. 1976. Monographie des *Typhula*, *Pistillaria* et genres voisins. Bulletin Mensuel de la Société Linnéene de Lyon 45: numéro spéc. 1-202.

Blackwell M, Malloch D. 1989. *Pyxidiophora*: Life histories and arthropod associations of two species. Canadian Journal of Botany 67: 2552-2562.

Blackwell M, Hibbett DS, Taylor JW, Spatafora JW. 2006. Research coordination networks: a phylogeny for kingdom *Fungi* (Deep Hypha). Mycologia 98: 829-837.

Cole GT, Samson RA. 1979. Patterns of development in conidial fungi. Pitman, London.

Crane JL, Shearer CA. 1977. *Rogersia*, a later name for *Filosporella*. Mycotaxon 6: 27-28.

Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew.

Eyjólfsdóttir GG. 1990. Fungi isolated from stained wood associated with bark beetle galleries in timber trees in New Zealand, Norway and Western Canada. PhD thesis, University of Manitoba.

Felsenstein J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. Evolution 39: 783-791.

Felsenstein J. 2006. PHYLIP (Phylogeny Inference Package) version 3.6a. Distributed by the author. Department of Genome Sciences, University of Washington, Seattle.

Gams W. 1971. *Cephalosporium*-artige Schimmelpilze (Hyphomycetes). Gustav Fischer Verlag, Suttgart.

Glawe DA. 1989. Variable proliferating of conidiogenous cells in *Diatrypaceae* and other fungi. Sydowia 41: 122-135.

Glawe DA, Rogers JD. 1982. Observations on the anamorphs of six species of *Diatrype* and *Diatrypella*. Canadian Journal of Botany 60: 245-251.

Hamada S, Fujita S. 1983. DAPI staining improved for quantitative cytofluorometry. Histochemistry 79: 219-226.

Hammill TM. 1972. Fine structure of annellophores. III. *Monotosporella sphaerocephala*. Canadian Journal of Botany 50: 581-585.

Hasegawa M, Kishino H, Yano T-A. 1985. Dating of the human-ape splitting by a molecular clock of mitochondrial DNA. Journal of Molecular Evolution 22: 160-174.

Hausner G, Reid J. 2004. The nuclear small subunit ribosomal genes of *Sphaeronaemella helvellae*, *Sphaeronaemella fimicola*, *Gabarnaudia betae* and *Cornuvesica falcata*: Phylogenetic implications. Canadian Journal of Botany 82: 752-762.

Hausner G, Wang X. 2005. Unusual compact rDNA gene arrangements within some members of the *Ascomycota*: Evidence for molecular co-evolution between ITS1 and ITS2. Genome 48: 648-660.

Hausner G, Eyjólfsdóttir GG, Reid J. 2003. Three new species of *Ophiostoma* and notes on *Cornuvesica falcata*. Canadian Journal of Botany 81: 40-48.

Hausner G, Reid J, Klassen GR. 1992. Do galeate-ascospore members of the *Cephaloascaceae, Endomycetaceae* and *Ophiostomataceae* share a common phylogeny? Mycologia 84: 870-881.

Hausner G, Iranpour M, Kim J-J, Breuil C, Davis CN, Gibb EA, Reid J, Loewen PC, Hopkin AA. 2005. Fungi vectored by the introduced bark beetle *Tomicus piniperda* in Ontario, Canada and comments on the taxonomy of *Leptographium lundbergii, L. terebrantis, L. truncatum* and *L. wingfieldii*. Canadian Journal of Botany 83: 1222-1237.

Hutchison LJ, Reid J. 1988. Taxonomy of some potential woodstaining fungi from New Zealand. 1. *Ophiostomataceae*. New Zealand Journal of Botany 26: 63-81.

Jacobs K, Kiristis T, Wingfield MJ. 2003. Taxonomic re-evaluation of three species of *Graphium*, based on morphology, ecology and phylogeny. Mycologia 95: 714-727.

Kawchuk LM, Hutchison LJ, Reid J. 1993. Stimulation of growth, sporulation, and potential staining capability in *Ceratocystiopsis falcata*. European Journal of Forest Pathology 23: 178-181.

Kendrick B. 1971. Conclusions and Recommendations. In: Kendrick B (ed), Taxonomy of Fungi Imperfecti. University of Toronto Press, Toronto, pp. 253-262.

Kiffer E, Morelet M. 2000. The Deuteromycetes. Science Publishers, Enfield, NH.

Koske RE Jr, Perrin PW. 1971. Basidiocarps, annelloconidia, and sclerotia in agar culture of *Pistillaria* (*Clavariadelphaceae*). Canadian Journal of Botany 49: 695-697.

Matsushima, T. 1995. Matsushima Mycological Memoirs 8: 1-44 & plates 1-89.

Minter DW, Sutton BC, Brady BL. 1983. What are phialides anyway? Transactions of the British Mycological Society 81: 109-120.

Nicholas KB, Nicholas HB Jr, Deerfield DW II. 1997. GeneDoc: Analysis and visualization of Genetic Variation. EMBNEW.NEWS 4: 14.

Oberwinkler F, Kirschner R, Arenal F, Villarreal M, Rubio V, Bergerow D, Bauer R. 2006. Two new pycnidial members of the *Atractiellales*: *Basidiopycnis hyalina* and *Proceropycnis pinicola*. Mycologia 98: 637-649.

Okada G, Takematsu A, Gandjar I, Nakase T. 1998a. Morphology and molecular phylogeny of *Tretopileus sphaerophorus*, a synnematous hyphomycete with basidiomycetous affinities. Mycoscience 39: 21-30.

Okada G, Seifert KA, Takematsu A, Yamaoka Y, Miyazaki S, Tubaki K. 1998b. A molecular phylogenetic reappraisal of the *Graphium* complex based on 18S rDNA sequences. Canadian Journal of Botany 76: 1495-1506.

Okada G, Jacobs K, Kiristis T, Louis-Seize GW, Seifert KA, Sugita T, Takematsu A, Wingfield MJ. 2000. Epitypification of *Graphium penicillioides* Corda, with comments on the phylogeny and taxonomy of graphium-like synneymatous fungi. Studies in Mycology 45: 169-188.

Page RDM. 1996. TREEVIEW: An application to display phylogenetic trees on personal computers. Computer Applications in the Biosciences 12: 357-358.

Posada D, Crandall KA. 1998. MODELTEST: Testing the model of DNA substitution. Bioinformatics 14: 817-818.

Ronquist F. 2004. Bayesian inference of character evolution. Trends in Ecology and Evolution 19: 475-481.

Ronquist F, Huelsenbeck JP. 2003. MRBAYES 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19: 1572-1574.

Schmidt HA, Strimmer K, Vingron M, von Haeseler A. 2002. TREE-PUZZLE: Maximum likelihood phylogenetic analysis using quartets and parallel computing. Bioinformatics 18: 502-504.

Schroers HJ, Samuels GJ, Seifert KA, Gams W. 1999. Classification of the mycoparasite *Gliocladium roseum* in *Clonostachys* as *C. rosea*, its relationship to *Bionectria ochroleuca*, and notes on other *Gliocladium*-like fungi. Mycologia 91: 365-385.

Seifert KA. 1985. A monograph of *Stilbella* and some allied hyphomycetes. Studies in Mycology 27: 1-235.

Seifert KA, Okada G. 1988. *Gloeosynnema*, a new genus of synnematous hyphomycetes with basdiomycetous affinities. Mycotaxon 32: 471-476.

Seifert KA, Okada G. 1990. Taxonomic implications of conidiomatal anatomy in synnematous Hyphomycetes. Studies in Mycology 32: 29-40.

Seifert KA, Okada G. 1993. *Graphium* anamorphs of *Ophiostoma* species and similar anamorphs of other ascomycetes. In: Wingfield MJ, Seifert KA, Webber JF (eds.), *Ceratocystis* and *Ophiostoma:* Taxonomy, Ecology and Pathogenicity. St. Paul, MI, USA. APS Press, p. 27-41.

Seifert KA, Samson RA, Boekhout T, Louis-Seize G. 1997. *Remersonia*, a new genus for *Stilbella thermophila*, a thermophilic mould from compost. Canadian Journal of Botany 75: 1158-1165.

Shearer CA, Crane JL. 1976. Illinois fungi No. 7. *Rogersia annelidica* gen. & sp. nov., an aquatic hyphomycete colonizing leaves in the Sagamon River. Mycologia 68: 946-950.

Sikaroodi M, Lawrey JD, Hawksworth DL, DePriest PT. 2001. The phylogenetic position of selected lichenicolous fungi: *Hobsonia*, *Illosporium*, and *Marchandiomyces*. Mycological Research 105: 453-460.

Sutton BC. 1980. *The Coelomycetes*. Commonwealth Mycological Institute, Kew.

Swann EC, Frieders EM, McLaughlin DJ. 2001. *Urediniomycetes*. In: McLaughlin DH, McLaughlin EG, Lemke PA, (eds), Systematics and evolution: The Mycota VII Part B. Springer Verlag, Berlin, pp. 37-56.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The Clustal-X Windows interface: Flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Research 25: 4876-4882.

Wang CJK. 1990. Ultrastructure of percurrently proliferating conidiogenous cells and classification. Studies in Mycology 32: 49-64.

Xia X. 2001. DAMBE: Data analysis in molecular biology and evolution. Journal of Heredity 92: 371-373.

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A new species of *Candelabrochaete* (*Polyporales, Basidiomycota*)

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Abstract — A new species of *Candelabrochaete* (*Corticiaceae, Polyporales, Basidiomycota*) is described and illustrated from specimens collected in two islands of the Macaronesian region, Faial (Azores) and Madeira. Affinities with other close species as *C. africana, C. langloisii* and *C. septocystidia* are discussed

Key words — *Aphyllophorales*, Macaronesia

Introduction

The genus *Candelabrochaete* was described by Boidin (1970) to include species characterized by a resupinate, adnate, smooth or tuberculate basidioma, brittle when dry; with a monomitic hyphal structure, consisting of wide, short, clampless hyphae, branched at right angles; with projecting septocystidia, subcylindrical to suburniform basidia, sometimes with linear repetition, and spores oblong to ellipsoid, thin-walled, smooth, inamyloid, acyanophilous.

Actually the genus comprises ten species with a worldwide distribution that are differentiated primarily based on basidiospore morphology (Table 1): subglobose in *C. dispar* Hjortstam & Ryvarden (Hjortstam & Ryvarden 1986); ellipsoid in *C. adnata* Hjortstam (Hjortstam 1995), *C. cirrata* Hjortstam & Ryvarden (Hjortstam & Ryvarden 1986), *C. eruciformis* (G. Cunn.) Stalpers & P. K. Buchanan (Stalpers & Buchanan 1991), *C. langloisii* (Pat.) Boidin (Boidin 1970), *C. magnahypha* (Burt) Burds. (Burdsall 1984), *C. simulans* Hjortstam

(Hjortstam 1995) and *C. verruculosa* Hjortstam (Hjortstam 1983); cylindrical to subcylincrical in *C. africana* Boidin (Boidin 1970); and allantoid in *C. septocystidia* (Burt) Burds. (Eriksson & al. 1978). The Macaronesian material has spores that are reniform to ellipsoid.

Roberts (2000) transferred *Peniophora mexicana* Burt to *Candelabrochaete,* making the new combination *C. mexicana* (Burt) P. Roberts without studying the type material. According to Burdsall (1984), *P. mexicana* has thick-walled spores and pseudocystidia, characteristics suggesting a relationship with the genera *Phanerochaete* P. Karst., *Candelabrochaete,* and *Hypochnicium* J. Erikss. We think that further studies are necessary to ascertain the correct position of this taxon and whether it should or should not be included in *Candelabrochaete.*

Materials and methods

A total of 12 specimens were collected during mycological forays to two islands of the Macaronesian region, Faial (belonging to the central group of the Azores archipelago) at the end of the winter of 2005 and Madeira during the summer of 2000 and autumn of 2006.

The material was studied following classical methods for the corticiaceous fungi: thin, freehand sections from each specimen were mounted in KOH (5%) and/or Melzer's reagent. These sections were examined under an Olympus BH50 microscope. M. Dueñas prepared line drawings with the aid of a Leica camera lucida. Color names are from the ISCC-NBS Color Names (Kelly & Judd 1976). Abbreviations include MD (M. Dueñas), Tell. (M.T. Telleria), and TFC (University of La Laguna Herbarium, where the E. Beltrán & J.L. Rodríguez-Armas collections are deposited).

Taxonomy

Candelabrochaete macaronesica M. Dueñas, Telleria & Melo, **sp. nov.** FIGS. 1 & 2
MYCOBANK MB 511289

Fructificatio resupinata, laeviter ad substratum unita, lutea-aurantiaca, cum margine fibrata, clariore. Systema monomiticum hypharum, fibulae rarissimae; septocystidia usque ad 150 × 8-11 µm; basidia quattuor sporarum, subcylindricorum ad subclavata (12-) 16-18.5 × 5-5.5 µm; sporae subcilyndricis ad anguste ellipticae, 5-6.5 × 2-3 µm. Holotypus MA-Fungi 72924.

HOLOTYPE: **PORTUGAL, AZORES, Faial,** Horta, Ponta do Varadouro, 26SLH4570, 42 m, on *Picconia azorica,* 21 Feb 2005, M. Dueñas, 10467MD, MA Fungi 72924.

ETYMOLOGY: from the Macaronesian region

KEY CHARACTERS — Fructification resupinate, adnate, yellow to orange yellowish, margin differentiated, fibrillose; hyphal system monomitic, basal hyphae slightly thick-walled, with scattered clamps, forming a thick subiculum

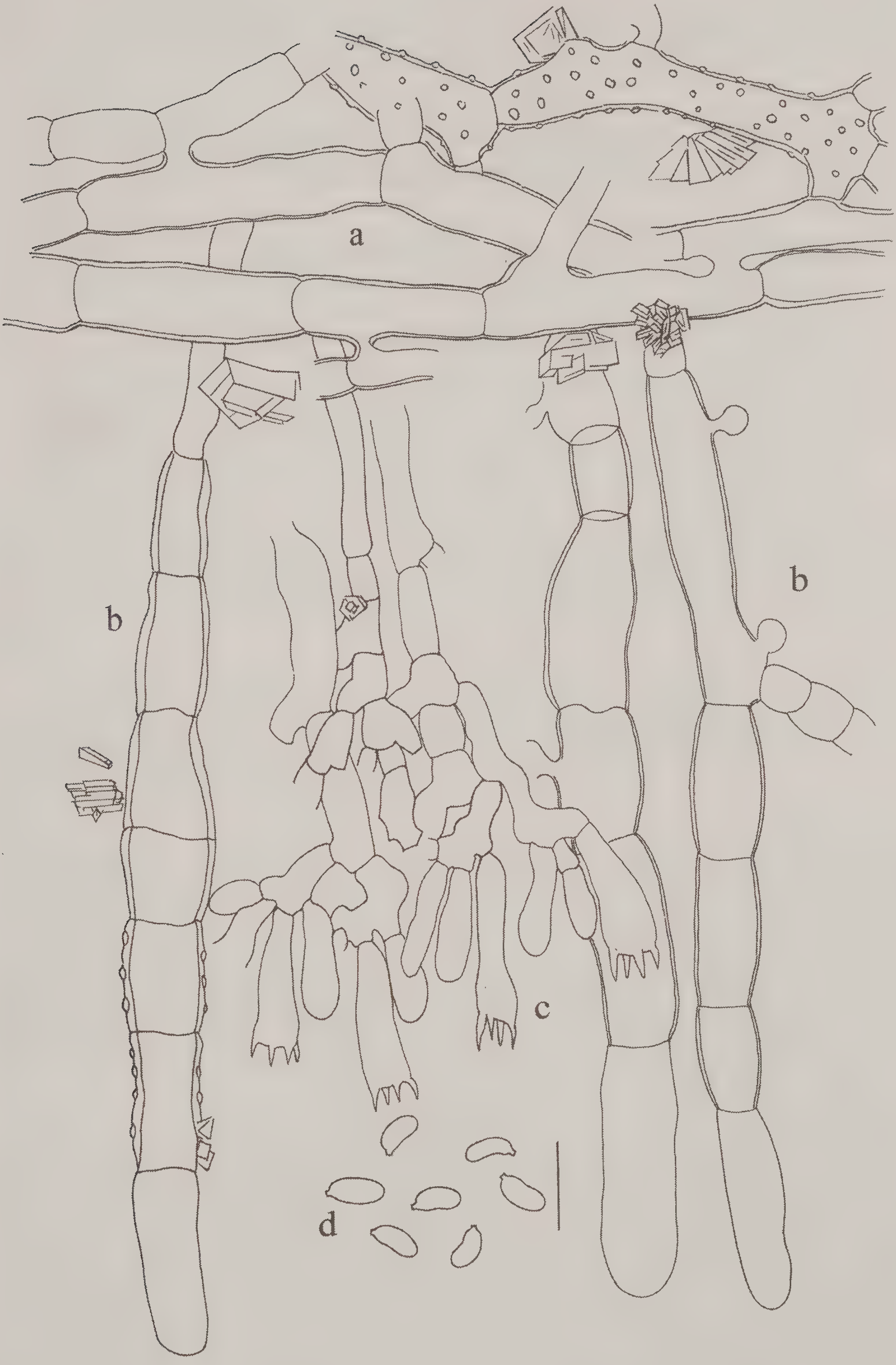

FIG. 1. *Candelabrochaete macaronesica*, MA-Fungi 72924 (holotype).
a: basal hyphae; b: septocystidia; c: basidia; d: basidiospores.
(Bar = 10 µm).

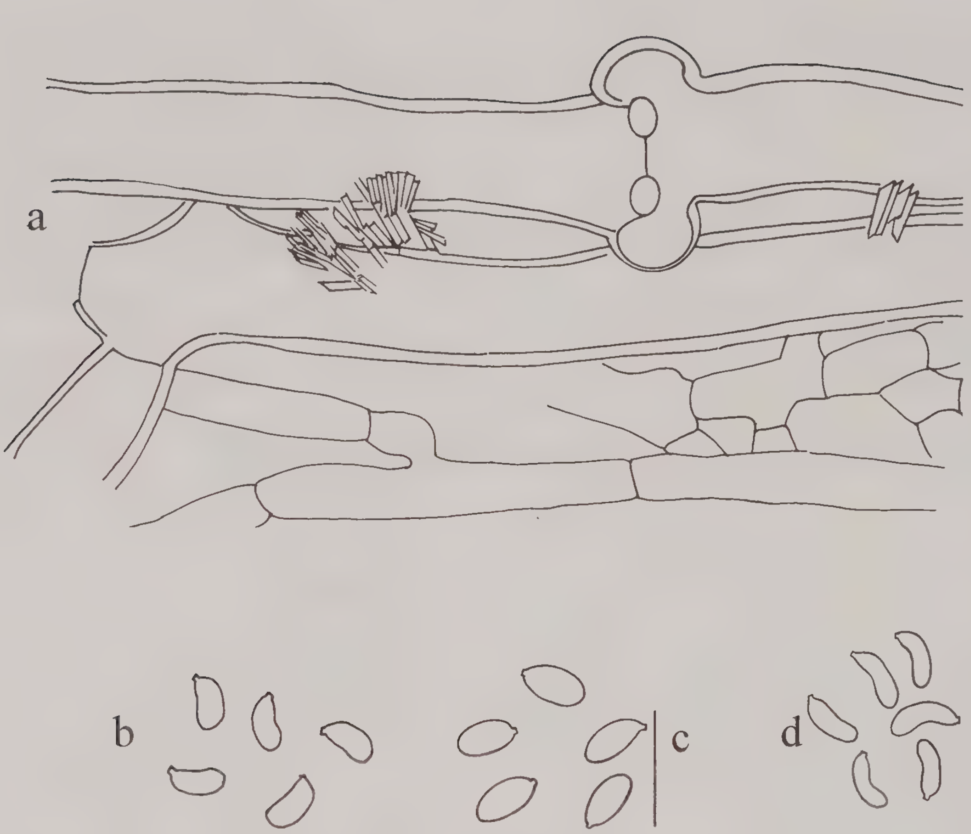

Fig. 2. *Candelabrochaete macaronesica*, MA-Fungi 72925, a: hyphae; b: basidiospores. *Candelabrochaete africana*, LY 5495 (holotype), c: basidiospores. *Candelabrochaete septocystidia*, MA-Fungi 7168, d: spores. (Bar = 10 µm).

visible under the lens; septocystidia up to 150 × 8-11 µm; basidia subcylindrical to subclavate (12-)16-18.5 × 5-5.5 µm; basidiospores cylindrical to narrowly ellipsoid, adaxially concave, 5-6.5 × 2-3 µm.

Basidiome resupinate, adnate, up to 2 mm thick, pellicular to membranaceous, yellow/orange-yellowish [70.I.OY/71.m.OY], pink in contact with KOH (5%); subiculum lighter; hymenophore mainly smooth, under the lens pilose from the projecting cystidia; margin differentiated, fibrillose, white.

Hyphal system monomitic; basal hyphae slightly thick-walled, 4-10 µm wide, short celled, sometimes with attached organic material giving them an irregular aspect, as a rule with simple septa — but specimen 10881MD with scattered clamps (Fig. 2) — , loosely interwoven, forming a thick subiculum visible under the lens; subhymenial hyphae thin-walled, 4-6 µm wide, more densely interwoven. Septocystidia cylindrical, arising from the basal hyphae and projecting through the hymenium, up to 150 × 8-11 µm, with barrel shaped cells, thin to slightly thick-walled, sometimes ramified; especially the basal hyphae and cystidia often provided with a cover of yellowish crystalline matter.

Basidia without linear repetition, subcylindrical to subclavate, (12-)16-18.5 × 5-5.5 µm, with 4 sterigmata. Spores cylindrical to narrowly ellipsoid, adaxially concave, thin-walled, smooth, hyaline, 5-6.5 × 2-3 µm, non-amyloid, non-cyanophilous.

Ecology and distribution — This new species has been collected from two islands, Faial (Azores) and Madeira, fruiting on decayed wood of *Picconia azorica* and *Occotea foetens.*

> Additional material studied (Paratypes) — **PORTUGAL. Azores: Faial,** Horta, Ponta do Varadouro, 26SLH4570, 42 m, on decayed wood, 21 Feb 2005, 16059Tell., MA Fungi 72929; 16061Tell., MA Fungi 72932; 16063Tell., MA Fungi 72926; on *Picconia azorica*, 10466MD, MA Fungi 72927; 10470 MD, MA Fungi 72933; 10473MD, MA Fungi 72928; 15182TFCMic; 15187TFCMic; 15193TFCMic. **Madeira: Santana,** Fajã da Nogueira, 28SCB2325, 850 m, on *Ocotea foetens*, 26 Jun 2000, 14108 Tell., MA Fungi 72934; **Santana,** Fajã da Nogueira, Montado do Leackok, 28SCB2024, 850 m, on trunk of *Ocotea foetens*, 19 Oct 2006, 10880MD, MA Fungi 72930; 10881MD, MA Fungi 72925; 10884bisMD, MA Fungi 72931 [together with *Hyphoderma argillaceum*].

Comments *C. macaronesica* resembles *C. langloisii* in the colour changing to pink in the presence of KOH. However, in the last species, the basidiospores in *C. langloisii* are also laterally depressed but are larger, 7-9.5 × 3-4 µm (Boidin 1970).

The presence of clamps on basal hyphae is not a frequent character in *Candelabrochaete*; however, *C. magnahypha*, described from Florida, has basal hyphae with scattered clamps (Burdsall 1984) but with ellipsoid and larger (6-7(-8) × 3-4 µm) spores.

The spores of this new species are similar in size to those of *C. verruculosa* and *C. africana,* but the former has grandinioid to odontoid hymenophores while the latter differs in its subcylindrical, laterally convex spores. Furthermore, *C. africana* has thick-walled hyphae and cystidia and basidia present linear repetition, as also noted for *C. verruculosa. C. septocystidia,* which was also collected from the same locality in the Azores, differs from *C. macaronesica* in the allantoid shaped and smaller sized (4-5 × 1.5-2 µm) spores (Fig. 2).

Acknowledgments

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TABLE 1. Diagnostic characters for described species of *Candelabrochaete*

SPECIES	HYMENOPHORE	COLOUR CHANGE IN KOH	CYSTIDIA SIZE (µm)	BASIDIA SIZE (µm)	SPORES	
					SHAPE	SIZE (µm)
C. adnata	smooth	no	40-60 × 6-8	17-20 × 4-5	ellipsoid	6.5-7 (-8) × 2.8-3.5
C. africana	smooth	no	up to 90 × 10	13-17 × 5-6	subcylindrical	4.5-6 × 2-3
C. cirrata	tuberculate	no	up to 40 × 10	17 × 6-7	ellipsoid	6-6.5 × 4-5
C. dispar	grandinioid to odontioid	no	80-120 (-200) × 6-9 (-10)	(12-)15-17 (-25) × 4-5 (-6)	subglobose	5-5.5 × 4-4.5
C. eruciformis	smooth to tuberculate	no	40-90 × 6-10	24-30 × 5-6	ellipsoid	7-9 × 3-5
C. langloisii	smooth	yes	75-200 × 9-15(-21)	15-18 × 6.5-8	ellipsoid	7-9.5 × 3-4
C. magnahypha	smooth	no	100-150 × 9-12	12-15 × 5.5-6	ellipsoid	6-7 (-8) × 3-4
C. mexicana	continuous to pubescent	no	90-150 × 9-20	9-11.5 × 6.5-7	ellipsoid to broadly ellipsoid	7-10 (-2) × (4-) 5-6
C. septocystidia	smooth	no	60-150 × 5-9(-12)	12-18 × 4.5-6.5	allantoid	4.5-6.5 × 1.5-2
C. simulans	smooth	no	100-250	20-25 × 4-5.5	ellipsoid	4.5-5.5 × 3-3.2
C. verruculosa	grandinioid to odontioid	no	70-140 × 8-12	15-20 × 4.5-5	ellipsoid	5.5-6 × 3-3.25
C. macaronesica	smooth	yes	70-150 × 8-11	(12-)16-18.5 × 5-5.5	subcylindrical to narrowly ellipsoid	5-6.5 × 2-3

Literature cited

Boidin, J. 1970. Basidiomycètes *Corticiaceae* de la Républic Centrafricaine II. Les genres *Botryobasidium* et *Candelabrochaete* nov. gen. Cahiers Maboké 8: 17-25.

Burdsall HH, Jr. 1984. The genus *Candelabrochaete (Corticiaceae)* in North America and a note of *Peniophora mexicana*. Mycotaxon 19: 389-395.

Eriksson J, Hjortstam K, Ryvarden L. 1978. The *Corticiaceae* of North Europe. vol. 5. Fungiflora, Oslo.

Hjortstam K. 1983. Studies in tropical *Corticiaceae (Basidiomycetes)* V: Specimens from East Africa, collected by L. Ryvarden. Mycotaxon 17: 555-572.

Hjortstam K. 1995. Two new species of *Candelabrochaete*. Mycotaxon 56: 451-453.

Hjortstam K, Ryvarden L. 1986. Some new and noteworthy fungi *(Aphyllophorales, Basidiomycetes)* from Iguazu, Argentina. Mycotaxon 25(2): 539-567.

Kelly KL, Judd DB. 1976. Color: Universal Language and Dictionary of Names,. Special Publication 440, National Bureau of Standards, Washington, DC. (U.S.).

Roberts P. 2000. Corticioid fungi from Korup National Park, Cameroon. Kew Bulletin 55(4): 803–842.

Stalpers JA, Buchanan PK. 1991. Type studies of species of *Pellicularia* and *Peniophora* described by G.H. Cunningham. New Zealand Journal of Botany 29: 331-340.

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Nomenclatural notes. 12. Untangling Hedwig's *Octospora villosa*: *Helvella fibrosa* comb. nov.

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Abstract — *Octospora villosa* was described and illustrated by Hedwig in 1789, and has been reassigned first as a variety in *Peziza*, and later at species rank in *Fuckelina*, *Cyathipodia*, and *Helvella*. Hedwig's species was sanctioned (at varietal level) by Fries, who treated it as *Peziza macropus* [var.] β *hirta*, an unintentional error in attributing to this taxon the epithet of a different Hedwig species. Error upon error has plagued Hedwig's species name, and an attempt here is made to untangle the most flagrant of these. Names in current use are *Helvella villosa*, *H. chinensis*, and *H. dissingii*. None turns out to be correct under the International Code of Botanical Nomenclature. Overlooked by all recent authors is the species name *Peziza fibrosa* proposed by Wallroth in 1833 as a new name to be substituted for *O. villosa* since that epithet could not be transferred to the genus *Peziza*, it being preoccupied there by Persoon's *P. villosa* of 1801. The new combination *Helvella fibrosa* is formally proposed, and an epitype specimen for *O. villosa* is designated.

Keywords — homonyms, sanctioned names, errors, corrected synonymy

Octospora villosa Hedwig

One of the most distinctive and beautiful plates of a *Helvella* is that provided by Hedwig (1789) as Tab. 19, B. It is an unmistakable species, closely resembling *Helvella macropus* (Pers.) P. Karst. but differing markedly in its dark hymenial color. Probably the best description of Hedwig's species is that by Dissing & Nannfeldt (1966) in which they proposed the new combination *Helvella villosa* (Hedw. ex Kuntze) Dissing & Nannf., which of course they could have cited as *H. villosa* (Kuntze) Dissing & Nannf. At the time they proposed this name, the 1961 edition of the International Code of Botanical Nomenclature (ICBN) still had as a starting point for *"fungi caeteri"* Fries's Systema Mycologicum (1821-32). This explains how "Kuntze" was part of their citation of authors. *O. villosa* was a pre-starting-point name, and apparently the first author to transfer *O.*

villosa to another genus was Kuntze (1891), who mentioned it as a species of his new genus *Fuckelina* Kuntze [itself an invalid later generic homonym of *Fuckelina* Sacc. (Saccardo, 1875)]. There are at least two earlier uses of the name *Helvella villosa* (some with the alternative generic name orthography of "*Elvela*") for other fungi, but these, too, were pre-starting-point names and did not constitute valid competing names under the 1961 ICBN. With the change of starting points for all fungi in the 1981 ICBN to a starting point of Linnaeus's *Species Plantarum* (1753), the Dissing & Nannfeldt combination became a later homonym, and thus illegitimate.

A major error was mine (Korf, 1988a), when in an attempt to provide a correct name in *Helvella* for Hedwig's species I proposed that it be called *Helvella dissingii* Korf. On publication of this name honoring my dear colleague, Henry Dissing, I was advised by him in an e-mail of a paper I had overlooked, Lundell et al. (1985), wherein Nannfeldt & Holm had earlier noted that *H. villosa* (Kuntze) Dissing & Nannf. was now a later homonym. They decided that the earliest available name for Hedwig's species was that of a species described by Velenovský (1939) as *Macropodia chinensis* Velen. They therefore proposed a new combination, *Helvella chinensis* (Velen.) Nannf. & L. Holm. I immediately pointed out my error (Korf, 1988b) in the errata page of a revision of my chapter in volume 5 of the reprint edition of Boudier's Icones Mycologicae. At the time of writing this paper (December 2007), the Index Fungorum website <www.indexfungorum.org/names/names.asp> erroneously still lists *H. dissingii* as the correct name for this taxon. As pointed out below, the choice of *H. chinensis* as the correct name was also an error.

Peziza fibrosa, a long forgotten obligate synonym

No recent author working with *O. villosa* seems to have realized that the name *Peziza fibrosa* Wallr. (Wallroth, 1833) was not proposed as a new species, but rather as a new name for *Octopsora villosa* Hedw., which was carefully cited as its synonym, including a reference to Hedwig's plate 19. Wallroth could not transfer Hedwig's species to *Peziza* because it would have become a later homonym of *Peziza villosa* Pers. published in 1801. Wallroth's name is typified by Hedwig's plate, the same illustration that serves as the lectotype of *O. villosa* itself and all the names based thereon. The name *P. fibrosa* was accepted by Kickx (1867), who provided additional information on specimens from Flanders. It was later transferred to *Macropodia* by Saccardo (1889), who also included the reference to Hedwig's name in the synonymy and to Kickx's treatment. Strangely, Nannfeldt, as well as Dissing, I, and all other recent authors, seem never to have taken *P. fibrosa* or *M. fibrosa* (Wallr.) Sacc. into account, despite the latter being a frequently cited synonym of Hedwig's *O. villosa*. Wallroth's species apparently provides the earliest epithet available for the species when treated in *Helvella*. The synonymy was clearly accepted by Kickx (1867), Saccardo (1889), Kuntze (1891), Mussat (1901), and Boudier (1907).

A chronicle of the major errors in date order

Fries, Systema Mycologicum (1821-32)

When Fries established his variety *Peziza macropus* var. *hirta* (Syst. mycol. 2: 57. 1822), he cited it as based upon "Octosp. hirta *Hedw. Musc. fr. 2. p. 54, t. 19. f. B.*" His major error was that he confused two Hedwig species names, *Octospora villosa* Hedw., which appears on that page and plate, and *O. hirta* Hedw., which appears elsewhere and was treated by Fries as a synonym of *Peziza scutellata.* Fries later recognized his error, and corrected the citations in his index (Syst. Mycol. 3 (index): 124. 1832) to indicate that *O. villosa* was the correct basionym for the variety. He did not, however, change the varietal epithet to "villosa," which surely would have been his decision ten years earlier had he not made the name error.

Streintz, Nomenclator Fungorum (1862)

This normally useful and quite exhaustive compendium of early names failed to record *Peziza fibrosa* Wallr., although other species from that work are cited.

Saccardo, Sylloge Fungorum 8 (1889)

Since Hedwig's *O. villosa* is not preoccupied in *Macropodia*, there was no reason to accept Wallroth's name in making the combination *Macropodia fibrosa.* Saccardo should have proposed a new combination based on Hedwig's name, not Wallroth's name. Both Saccardo and Mussat (1901) assumed Fries's (sanctioned) *P. macropus* [var.] β *hirta* (Hedw.) Fr. was a synonym of Persoon's earlier treatments of a homonymous *P. macropus* [var.] β *hirta* Pers., which Fries did not mention or sanction.

Kuntze, Revisio Genera Plantarum 2: 852. (1891)

This author proposed a new genus, *Fuckelina,* including Hedwig's species as *F. villosa* (Hedw.) Kuntze, one of several new combinations, unaware that there was an earlier generic name *Fuckelina* (Saccardo 1875).

Arnould, Bull. Soc. Mycol. France 14:111. (1893)

This paper includes the new combination *Leptopodia villosa* (Schaeff.) Boud., an error in which *Helvella villosa* Schaeff. was incorrectly assumed to be an earlier synonym of *Octospora villosa* Hedw. Schaeffer's name is unquestionably that of another species. This combination is thus not a synonym of *O. villosa,* but a misapplication. Arnould was in contact with Boudier, and knew of Boudier's (1885) treatment of the *Discomycetes,* and of the generic name *Leptopodia* Boud. which had been proposed there. But whether Boudier approved of the transfer to *Leptopodia* or of the change from Hedwig to Schaeffer as the author of the epithet is unkown.

Boudier, Liste préliminaire (1904)

The generic name *Cyathipodia* Boud. is generally treated as having been published in his Histoire et Classification des Discomycètes d'Europe (Boudier 1907), but three species were combined under this generic name by Boudier in this 1904 document, *C. villosa* (Hedw.) Boud., *C. dupainii* (Boud.) Boud., and *C. corium* (O. Webereb.) Boud. No generic description appears there. The generic name *Cyathipodia* appears not to have been formally proposed prior to Boudier's Histoire (Boudier 1907), so that none of these three combinations can be considered as validly published in 1904.

Lundell, Nannfeldt & Holm, Publ. Herb. Univ. Upsal. 18 (1985)

The choice of *Helvella chinensis* (Velen.) Nannf. & L. Holm as the correct name was not an error under the 1981 ICBN, but the authors' ignorance of the nomenclatural status and availability of *Peziza fibrosa* Wallr. was an error. Their assumption that the earliest available synonym was *Macropodia chinensis* Velen., not published until 1939, seems in retrospect to have been naïve. Any earlier taxonomic synonym found would automatically have reduced their combination to synonymy. *Peziza fibrosa* was published over a century earlier.

Korf, in Boudier's Icones Mycologicae (rev. edition) 5: 215. (1986)

In this work I cited the correct name as "*Helvella villosa* (Hedw. : Fr.) Diss. & Nannf." and a synonym as "*Cyathipodia villosa* (Hedw. : Fr.) Boud." These formulations were used to indicate that Fries was the sanctioning author. My reasoning was that since Fries had listed *Octospora villosa* Hedw. in the index to volume 3 of the sanctioning work, he had clearly accepted and thus sanctioned the name. I should not, however, have used the formulation ": Fr." since Hedwig's name was only sanctioned at varietal rank, not at species rank. It is incontrovertible that Fries did accept *Octospora villosa* Hedw. as the basionym for his treatment of *Peziza macropus* var. *hirta* when he corrected his original mistake in the Index. The epithet "*hirta*" was and is clearly a *lapsus calami* that was never changed to "*villosa*."

Korf. Mycotaxon 31: 381. (1988a)

Here my errors were twofold — first, in not being aware of the paper by Lundell et al. (1985) and thus in proposing the superfluous new name *Helvella* *dissingii* as mentioned above and secondly, of course, in being equally unaware of the nomenclatural status of *Peziza fibrosa.*

Korf, Chapter reprint. Errata p. 48 (1988b)

In this document I accepted the name proposed by Lundell et al. (1985), which I should not have done had I been aware of Wallroth's valid epithet.

The corrected synonymy

Helvella fibrosa (Wallr.) Korf, **comb. nov.**

MycoBank: MB 511344

≡ *Peziza fibrosa* Wallr., Fl. Crypt. Germ. 2: 498. 1833 (basionym), [Nomen novum, typus: *Octospora villosa* Hedw. *non Peziza villosa* Pers., Syn. meth. fung. 2: 655. 1801.]

≡ *Octospora villosa* Hedw., Descr. micro-anal. musc. p. 54, t. 19. fig. B. 1789. Epitype (selected here): Lundell, Nannfeldt & Holm, Fungi exsiccati Suecici praesertim Upsaliensis # 3262. 1985. (UPS).

≡ *Peziza macropus* [var.] β *hirta* (Hedw. : Fr.) Fr., Syst. Mycol. 2: 57. 1822. [Basionym *O. villosa* Hedw. Epithet "*hirta*" was an unintentional 1822 error (acknowledged 1832, Index p. 124) for "*villosa*."]

≡ *Macropodia fibrosa* (Wallr.) Sacc., Syll. Fung. 8: 160. 1889.

≡ *Fuckelina villosa* (Hedw.) Kuntze, Rev. Gen. Pl. 2: 852. 1891.

≡ *Cyathipodia villosa* (Hedw.) Boud., Hist. classific. discomyc. Europe p. 39, 1907.

≡ *Helvella villosa* (Hedw.) Dissing & Nannf., Svensk Bot. Tidskr. 60: 330. 1966. [ut *H. villosa* (Hedw. ex Kuntze) Dissing & Nannf.], later homonym, non *H. villosa* Schaeff. 1774.

≡ *Helvella dissingii* Korf, Mycotaxon 31: 381. 1988, superfluous name.

= *Macropodia chinensis* Velen., Novitat. Mycol. p. 200. 1939.

≡ *Helvella chinensis* (Velen.) Nannf. & L. Holm, in Lundell, Nannfeldt & Holm, Publ. Herb. Univ. Upsal. 18: 5. 1985.

Misapplication: *Leptopodia villosa* (Schaeff.) Boud., in Arnould, Bull. Soc. Mycol. France 9: 111. 1893.

≡ *Helvella villosa* Schaeff., Fung. Bavar. Palat. nasc. 4: 114. 1774.

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Literature cited

Arnould L. 1893. Liste des espèces de champignons récoltées en Picardie pendant les années 1890-91 et 92. Bull. Soc. Mycol. France 9: 98-112.

Boudier [JL]É. 1886. Nouvelle classification des discomycètes charnus. Bull. Soc. Mycol. France 1: 91-120.

Boudier [JL]É. 1904. Icones mycologicae, Liste préliminaire. Paris. 4 pp.

Boudier, [JL]É. 1907. Histoire et Classification des Discomycètes d'Europe. Paris. 222 pp.

Dissing H, Nannfeldt JA. 1966. *Helvella cupuliformis* sp. nov., *H. villosa* (Hedw. ex O. Kuntze) comb. nov., *H. macropus* (Pers. ex Fr.) Karst., and their allies. Svensk Bot Tidskr. 60: 325-337, pl.1-3.

Fries E. 1821-32. Systema mycologicum. 3 vols + index. 1-2 Lund, 3 + index Greifswald.

Hedwig J. 1789. Descriptio et adumbralio microscopico-analytica muscorum frondosorum 2. Lipsiae. 112 pp., 40 pl.

Kickx J. 1867. Flore cryptogamique des Flandres. 1. Paris. 512 pp.

Korf RP. 1986. A compendium of acceptable names for species illustrated in volumes 2 and 3 of Boudier's Icones mycologicae. [Also in French.] In Boudier, É. Icones mycologicae, vol. 5 (of reprint edition). Editions Piantanida, Lausanne. pp. 209-252.

Korf RP. 1988a. Some forgotten discomycete combinations. Mycotaxon 31: 379-382.

Korf RP. 1988b. A compendium of acceptable names for species illustrated in volumes 2 and 3 of Boudier's Icones mycologicae. Annotated errata, some necessary changes in citations, and suggested changes based on recent taxonomic information. Ithaca. 48 pp.

Kuntze O. 1891. Revisio generum plantarum. 2. Leipzig. pp. 375-1011.

Linnaeus C. 1753. Species plantarum. 2 vols. Holmiae.

Lundell S, Nannfeldt JA, Holm L. 1985. Fungi exsiccati suecici praesertim Upsaliensis, fasc. 66. Publ. Herb. Univ. Upsal. 18: 1-17.

Mussat É. 1901. [Saccardo PA] Sylloge fungorum 15. Patavii. 455 pp.

Saccardo PA. 1875. Fungi Veneti novi vel critici, Series II. Nuovo Giorn. Bot. Ital. 7: 299-329.

Saccardo PA. 1889. Sylloge fungorum 8. Patavii. 1143 pp.

Streinz WM. 1862. Nomenclator fungorum. Vindobonae. 736 pp.

Velenovský, J. 1939. Novitates mycologicae. Pragae. 211 pp.

Wallroth FW. 1833. Flora cryptogamica Germaniae. 2. Paris. 923 pp. [Also issued in Bluff MJ. 1833. Compendium florae Germaniae, sectio 2. tomus 4, Nürnberg. 923 pp.]

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Camarotella brasiliensis sp. nov. (*Phyllachoraceae*) on *Syagrus schizophylla* (*Arecaceae*) from Brazil

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Abstract — A new *Camarotella* species found in the States of Bahía and Sergipe, Brazil, on an arecaceous host (*Syagrus schizophylla*) is here described. The new species, *C. brasiliensis*, is distinguished from the other congeneric species by ascospore size, a persistent mucous sheath surrounding the ascospores, and ascus shape and width.

Key words — neotropical fungi, *Phyllachorales*, palm, ascomycetes

Introduction

Arecaceae are plants of pantropical distribution with major diversity in Brazil (Alves & Demattê 1997). Hyde et al. (1997) listed 1,580 fungal species on palms, including 650 ascomycetes, 270 basidiomycetes, 400 hyphomycetes and 260 coelomycetes. In Brazil a total of 92 fungal species were recorded on arecaceous species by Mendes et al. (1999). Among them the ascomycetes predominated with 46 species. Sanchez et al. (2003) issued a preliminary report of a new species of *Camarotella* Theiss. & Syd. on *Syagrus schizophylla* (Mart.) Glassman (*Arecaceae*) from the state of Sergipe, collected in 1997. In the course of preparing this paper, however, the authors discovered that the same fungus had been found earlier in 1986, in Valença, Bahía. This new species is now described and named.

Materials and methods

Specimens of *Syagrus schizophylla* collected in Bahía were incorporated into the CEPEC Herbarium in Itabuna, Bahía, and those from the coastal area of Sergipe, Brazil deposited in the Mycological Collection of the Herbarium of the University of Brasília (UB- Col. Micol.). Observations under the stereomicroscope were followed by study of squash preparations and stromatic sections made with a freezing microtome. Morphological features were described, measured, and photographed using a Zeiss-Axiophot E microscope. In most cases, the samples were stained with lacto-glycerol cotton blue and the slides sealed with nail polish. A minimum of fifty replicates were made of each spore dimension.

Taxonomy

Camarotella brasiliensis C.A.P. Souza, Vitória, J.L. Bezerra, Inácio & Dianese, **sp. nov.** FIGS. 1-2.

MycoBank MB 511338

Stromata nigra 0.2–0.6 × 1.4–2.6 mm, elongata, unilocularia, raro multilocularia, subepidermalia, erumpentia. Ascomata 171–427 × 209–684 µm, subglobosa, erumpentia, ostiolata, externa cum pariete texturae angularis composita. Periphyses hyaline, 1.0–2.5 µm diam. Paraphyses 1.6–2.7 µm lata, filiformes, hyalina, septata, ramosae, copiosae. Asci 72–168 × 14–48 µm, clavati, unitunicati, octospori. Ascosporae 36–60 × 5–7 µm, hyalinae, pallido-brunneae, elongato-fusiformes, aseptatae, multiguttulatae, vagina mucosa irregularis involutae. Conidiomata ad 600 µm diam. Cellulae conidiogenae 1.0–1.5 µm diam. Conidia 3.0–14.5 x ca 0.5 µm, filiformia, recta vel sigmoidea, aseptatae, hialina.

LESIONS black linear pustules along the foliar veins, 0.8–1.4 x 0.5–0.8 mm. STROMATA 0.2–0.6 (mean 0.5) × 1.4–2.6 (mean 1.9) mm, strongly erumpent, mostly unilocular, black discrete or confluent, mostly epiphyllous, occasionally hypophyllous, flat at the base, brown to black, sometimes coated by a temporary yellow pigment, carbonaceous, subglobose to ellipsoid, rough; walls pseudoparenchymatous, black, opaque, formed by host cells colonization. ASCOMATA 171–427 (mean 307) × 209–684 (mean 402) µm, subglobose, erumpent through the stromata, ostiolate, with outer wall composed of TEXTURA ANGULARIS, ostiole central, aplanate, rounded, slightly ribbed, lined internally by hyaline periphyses. PERIPHYSES hyaline, 1.0–2.5 µm diam. PARAPHYSES 1.6–2.7 µm diam, hyaline, filiform, septate, branched, abundant. ASCI 72–168 (mean 125) × 14–48 (mean 25) µm, clavate, unitunicate, short-stalked, thin-walled, 8-spored. ASCOSPORES 36–60 (mean 46) × 5–7 (mean 6.5) µm, hyaline to pale brown, elongate-fusiform, aseptate, multiguttulate, surrounded by an irregular wide mucilaginous sheath. CONIDIOMATAL STROMATA erumpent from the epidermal and hypodermal host cells, sometimes subcuticular, pulvinate, subglobose, but sometimes a little elongate, carbonaceous, black, shiny, disposed as the ascal stromata, 0.2–0.6 mm wide. CONIDIOMATA immersed in the stroma, dimidiate, black, 320 µm wide and 176 µm high, of thin walls, thicker at the base. CONIDIOGENOUS CELLS phialidic, lining the whole pycnidial locule, arranged in palisade, hyaline, branched, 1.0–1.5 µm wide,

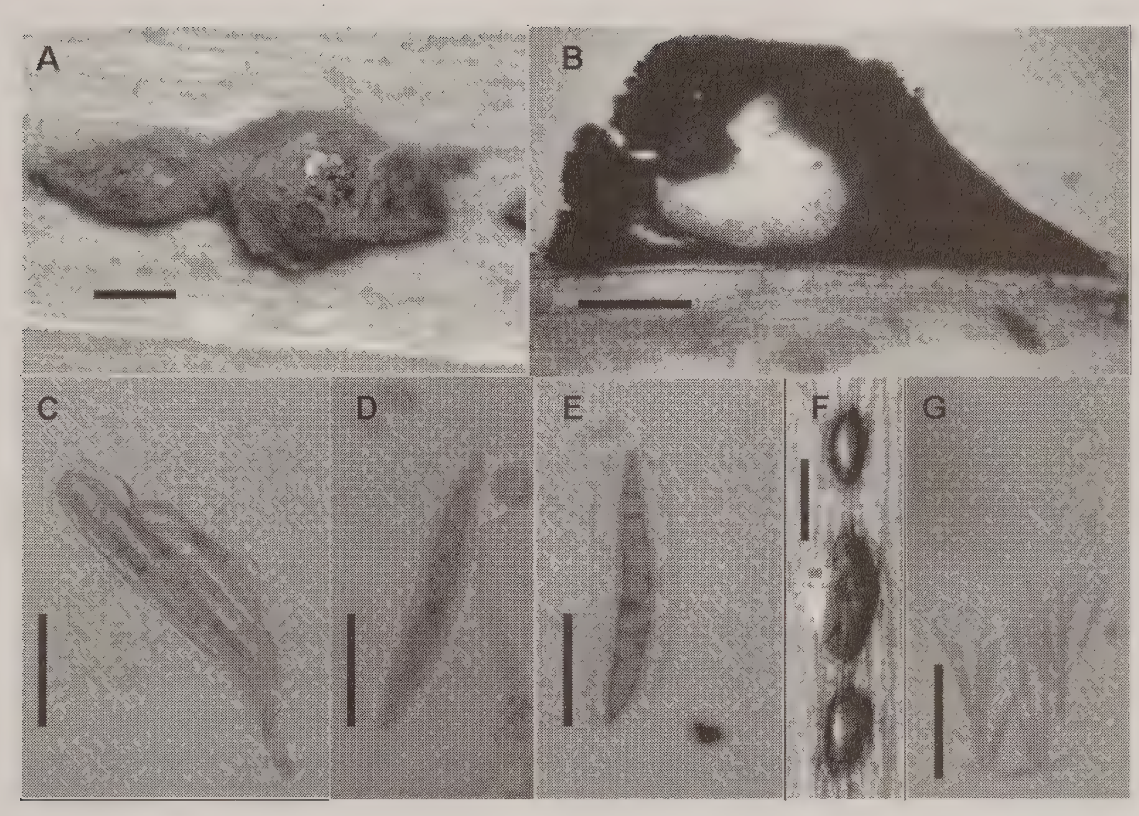

Fig. 1. *Camarotella brasiliensis* on *Syagrus schizophylla*: A. Perithecial stroma (bar = 0,5 mm); B. Lengthwise section of perithecia (bar = 50 µm); C. Asci (bar = 30 µm); D-E. Ascospores (note mucilaginous sheath surrounding spores) (bar = 30 µm); F. Pycnidial stromata (bar = 0.5 mm); G. Conidiophores and conidia. (bar = 30 µm).

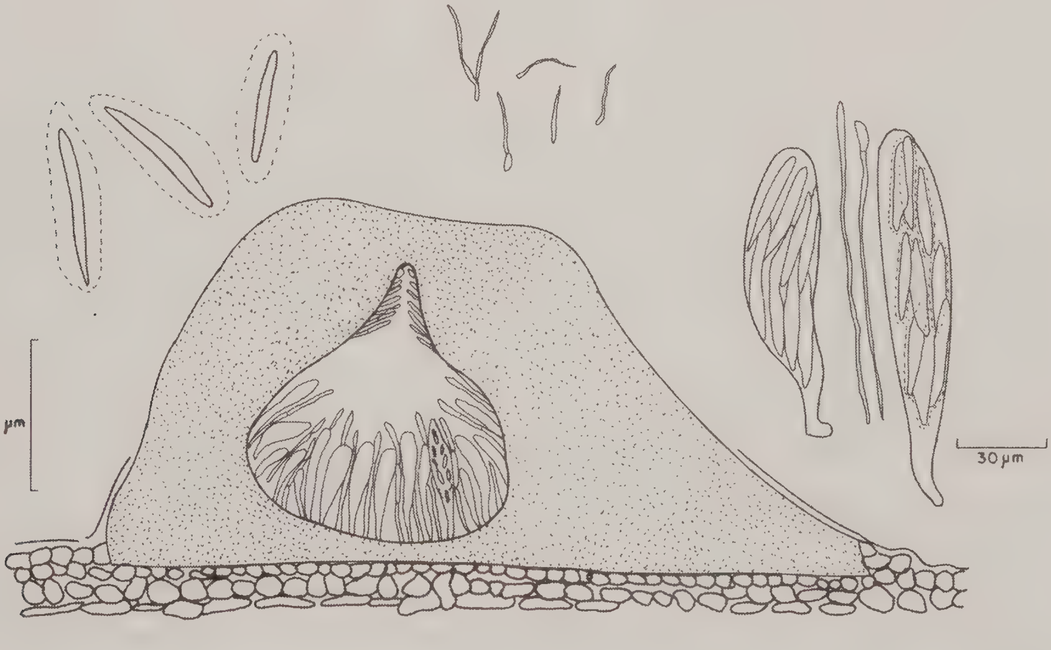

Fig. 2. *Camarotella brasiliensis* on *Syagrus schizophylla*: A. Perithecium with asci, paraphysis, ascospores and periphysis (bar = 50 µm). B. Asci and paraphysis (bar = 30 µm). C. Ascospores with mucous sheath (bar = 30 µm). D. Conidiophore and conidia (bar = 30 µm).

apex acuminate. Conidia filiform, hyaline, curved, sigmoid, acropleurogenous, 3.0–14.5 x 1.0 µm, aseptate.

Specimens examined. BRAZIL. BAHÍA: Municipality of Valença, on leaflets of *Syagrus schizophylla*, 25 Feb 1986, *leg.* L. Hage 1946, (CEPEC Herbarium Mycological collection, 686, **holotype**). SERGIPE: north coastal region, on living leaves of *Syagrus schizophylla*, 10 April 1997, *leg. Dulce Warwick* 03, (UB- Col. Micol. 13.720).

Discussion

Theissen & Sydow (1915) described the genus *Camarotella* as having thick walled asci and hyaline, four-celled ascospores. Petrak (1940) later revised this genus to correct Theissen & Sydow's description. According to Petrak, the asci are unitunicate and the ascospores unicellular. Clements & Shear (1931) and Wehmeyer (1975) treated the genus *Camarotella* but ignored the changes introduced by Petrak (1940).

Hyde & Cannon (1999), who examined parasitic fungi causing tar spots and similar diseases on palms, reevaluated the genus *Camarotella* and defined the following diagnostic characters: stromata that are black, pulvinate, strongly erumpent, and disposed in linear rows; anamorphs formed in thin-walled stromatic locules with pointed conidiogenous cells of percurrent proliferation and filiform, acuminate, curved conidia; one to several ascomata per stroma that are elongated towards the foliar veins; 8-spored asci that are unitunicate, cylindrical or cylindrical-clavate in shape and with or without an apical ring; ascospores that are short-fusiform, hyaline to light brown, unicellular, and surrounded by a mucilaginous sheath. *Camarotella acrocomiae* (Mont.) K.D. Hyde & P.F. Cannon was recognized as the type for this genus.

Hyde & Cannon (1999) further suggested a close relationship among species of *Camarotella*, *Oxodeora* K.D. Hyde & P.F. Cannon, and *Coccostromopsis* Plunkett. Species of *Oxodeora* produce stromata emerging through the leaf epidermis in a linear pattern, similar to those of *C. brasiliensis*; however, *Oxodeora* ascospores are ornamented with wide irregular ridges. *Coccostromopsis* stromata are superficial, pulvinate, and contain several locules, but the stromata are gelatinous with a yellowish outer layer when young, which distinguishes them from the *C. brasiliensis* specimens studied.

Coccodiella Hara is another black phyllachoraceous genus. *Camarotella* species form pulvinate leathery stromata as opposed to *Coccodiella* species with stromata that are flat, somewhat gelatinous, and with constricted bases (Cannon 1996, Hyde & Cannon 1999). Another major distinction lies in the conspicuous gelatinous sheath surrounding *Camarotella* ascospores that is lacking in *Coccodiella* (Hyde & Cannon 1999).

Camarotella species also differ from those of *Sphaerodothis* (Sacc. & P. Syd.) Shear. *Sphaerodothis* ascomata are never erumpent and produce short cylindrical asci and globose brown ascospores.

Two other *Camarotella* species are known to occur on *Arecaceae* — *C. acrocomiae* (ascospores 20–29 × 7.5–10 µm) and *C. costaricensis* (F. Stevens) K.D. Hyde & P.F. Cannon (ascospores 15–20 × 9–10 µm). The Bahía and Sergipe specimens have much longer (36–60 µm) and narrower (5–7 µm) ascospores that are distinctly fusiform and multiguttulate, with up to 8 large guttules per ascospore. These differences clearly show that the fungus belongs to a new *Camarotella* species, here designated as *C. brasiliensis.*

Key to *Camarotella* species

1. Ascospores short-fusiform, not exceeding 30 µm long 2
1'. Ascospores elongate-fusiform, multiguttulate, exceeding 30 µm long ... *C. brasiliensis*
2. Ascospores oblong to ellipsoid, blunt at both ends, usually brown ...... *C. acrocomiae*
2'. Ascospores fusoid, acute at both ends, usually hyaline to yellowish ... *C. costaricensis*

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References

Alvez MRP, Dematté MESP. 1997. Palmeiras: características botânicas e evolução. Fundação Cargill: Campinas (Brazil). 129 pp.

Cannon PF. 1996. *Coccodiella arundinariae.* IMI Descriptions of Fungi and Bacteria 128: 1-2.

Clements FE, Shear CL. 1931. The Genera of *Fungi.* New York: Hafner Publishing Co.

Hyde KD, Cannon PF. 1999. Fungi causing tar spots on palms. Mycological Papers 175: 1-114.

Hyde KD, Fröhlich J, Taylor J. 1997. Diversity of ascomycetes on palm in the tropics. In: Hyde KD (ed.), Biodiversity of tropical microfungi. Hong Kong University Press, Hong Kong: 141-156.

Mendes MAS, Silva VL, Dianese JC, Ferreira MASV, Santos CEN, Neto EG, Urben AF, Castro C. 1998. Fungos em Plantas no Brasil: Embrapa – SPI / Embrapa – Cenargen, Brasília, Brazil..

Petrak F. 1940. Über die Gattung *Camarotella* Theiss. et Syd. Annales Mycologici 38: 245.

Sanchez M, Souza CAP, Dianese JC. 2003. Uma nova espécie de *Camarotella* sobre folhas de *Syagrus schizophylla.* Fitopatologia Brasileira (Suppl.) 28: 224.

Sydow H. 1925. Fungi from the province of Sorsogon. Leaftlets of Philippine Botany 9: 3113–3118.

Theissen F, Sydow H. 1915. Die *Dothideales.* Annales Mycologici 13: 370.

Wehmeyer LE. 1975. The Pyrenomycetous fungi. Mycologia Memoir 6: 51.

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Postia ptychogaster, an unusual two-stage polypore new to Italian mycobiota

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Abstract — *Postia ptychogaster* is reported from Italy for the first time. It was collected on a dead rotten trunk of *Abies alba* in a natural park, and was associated with a brown cubical rot. This species is well characterized by basidiomes closely associated with a typical *Ptychogaster* anamorphic stage forming large conidiomata. A full description, including photographs of both basidiomes and conidiomata and line drawings of microscopic characters, is provided.

Key words — biodiversity, wood-inhabiting fungi, chlamydospores, conidial stage, *Oligoporus*

Introduction

In the *Oligoporus/Postia* assemblage (*Agaricomycetes*, *Polyporales*, *Fomitopsidaceae*) taxonomy is still somewhat unsettled and in flux (Niemelä 2005, Niemelä et al. 2005, Spirin et al. 2006). Apart from Yao et al. (1999), thorough molecular analyses on these taxa have not yet been performed, and are urgently needed. In the meanwhile, according with Vesterholt & Knudsen (1997), Pieri & Rivoire (2006), and Wei & Dai (2006), the genus *Postia* Fr. s.l. encompasses saprotrophic polypores characterized by a soft, effused-reflexed or flabelliform-pileate basidiome, annual or short-lived, white to pale coloured (some species have a rusty-brown upper surface), a monomitic hyphal system with thin- to distinctly thick-walled hyphae with clamp connections, small, allantoid, narrowly ellipsoid to sub-cylindrical spores, a brown rot and occurrence mainly on gymnosperms. Some species have well-differentiated cystidia and are able to form chlamydoconidia both in nature and in pure culture (Gilbertson & Ryvarden 1987, Ryvarden & Gilbertson 1994, Stalpers 2000, Niemelä 2005, Pieri & Rivoire 2006).

Field mycological investigations in an artificial plantation of *Picea abies* (L.) H. Karst. and *Abies alba* Mill. located in the "Parco naturale della Collina di Superga", a park hill area near Turin, Piedmont (northern Italy), yielded several specimens of *Postia ptychogaster*. This polypore, until now unknown from Italy (Ryvarden & Gilbertson 1994, Bernicchia 2005, Onofri et al. 2005), was found on a decayed fallen trunk of *Abies alba*, both in its anamorphic and its teleomorphic state. The aim of this paper is to provide a complete description of this rare species and to extend its geographic and hosts range.

Materials and methods

Basidiomes and conidiomata were examined both macro- and microscopically with a stereo microscope (Leica MZ12) and a compound microscope (Leica DM4500B), respectively. Photographs were taken using a Leica DFC320 digital camera mounted on the compound microscope. The description of the microscopic features is based on fresh specimens. Sections were mounted in distilled water, in lactic acid plus acid fuchsine, in 5% potassium hydroxide, in Melzer's reagent, and in Cotton Blue. For conidia, basidia, and other structures at least 30 individuals were measured. The following abbreviations are used: Q = length to width ratio of the spores in side view; Qm = average quotient; IKI stands for Melzer's reagent, and CB is the abbreviation of Cotton Blue. CB^+ and CB^- means cyanophilous and acyanophilous, respectively; IKI^- means inamyloid and indextrinoid.

The abbreviation *P.* stands for '*Postia*' and *Pt.* for '*Ptychogaster*'. The colour notations in brackets are taken from Kornerup & Wanscher (1978), indicated as M. before a colour code. All examined material is deposited and kept at GDOR (Herbarium of the Museo Civico di Storia Naturale Giacomo Doria, Mycologia section, Genova, Italy). Herbarium abbreviations follow Holmgren & Holmgren (1998).

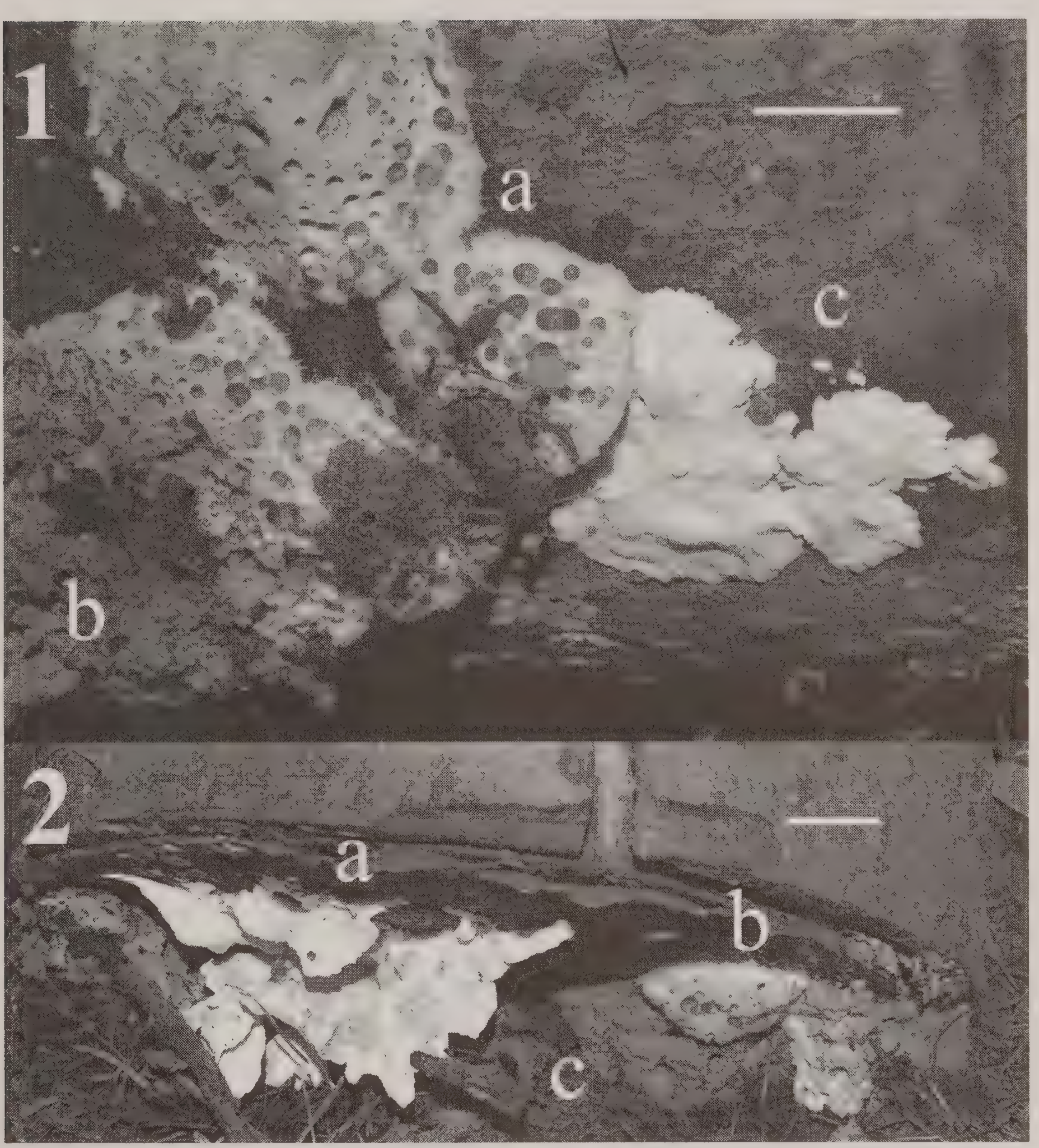
Taxonomy

Postia ptychogaster (F. Ludw.) Vesterh., in Knudsen & Hansen, Nordic J. Bot. 16: 213 (1996) FIGS. 1-9

= *Oligoporus ustilaginoides* Bref.; *Tyromyces ptychogaster* (F. Ludw.) Donk; *Oligoporus ptychogaster* (F. Ludw.) Falck & O. Falck

Anamorph: *Ptychogaster fuliginoides* (Pers.) Donk, Proc. K. Ned. Akad. Wet. 74: 124 (1972) [= *Ptychogaster pulverulentus* (Sowerby) Stalpers; *Ptychogaster albus* Corda; *Ptychogaster flavescens* Falck & O. Falck].

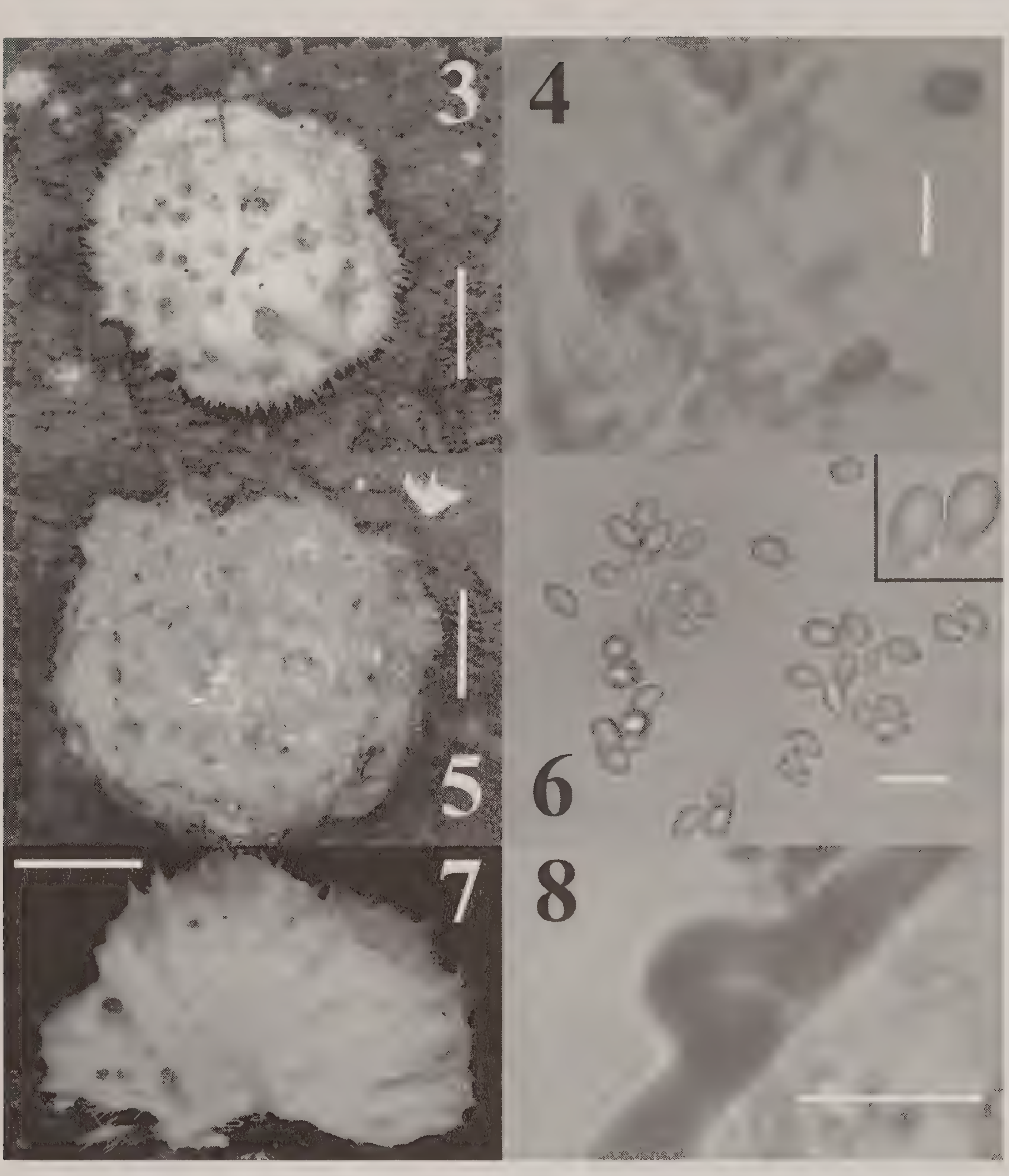
Anamorphic, conidial stage (FIGS. 1A,C; 2B,C; 3-8). Conidioma [= chlamydosporocarp sensu Clémençon (2004), ptychogasteroid or chlamydosporic fruitbody sensu Domański (1972)] always preceding basidioma development, as a hemispherical pulvinate, cushion-shaped structure, 2-5 cm in diam.,



Figs. 1–2. *Postia ptychogaster*. **Fig. 1: a.** Young conidiomata. **b.** Effuse-resupinate basidiome. **c.** Powdery mass of chlamydoconidia. Fig. 2: **a.** Pileate basidiomes. **b.** Young conidiomata. **c.** Powdery mass of chlamydoconidia. Scale bars = 10 mm.

1-2.5(3) cm thick, usually shortly stipitate; when young white, sometimes with pink hues, loose and cheesy, spongy, watery, easily collapsing, slightly concentrically zoned in vertical cross section, exuding small amber-brown to cherry-red droplets [M. (6-9)A8; reminiscent of primordia of *Abortiporus biennis* (Bull.) Singer and *Hydnellum peckii* Banker], with an aculeate-villose surface consisting of soft, tufted hairs; when mature disintegrating into an ochraceous, powdery mass of conidia [at this stage it can be mistaken for an old myxomycete (Ryvarden & Gilbertson 1994, Clémençon 2002)]. By confluence the conidiomata can form irregular masses reaching 6-8 cm or more in extent. Inner part of the conidioma prosenchymatic, at first consisting mainly of 70-110 µm wide synnema-like bundles of hyphae, running radially from a single basal core; at maturity composed of hyphae and brown powdery masses of conidia. Hyphae hyaline, thin- to slightly thick-walled, (3-)4.8(-7.5) µm wide, with abundant clamp connections. Clamps usually sprouting, perforate, often with a considerable open space between the hypha and the anastomosing body [medallion type (Stalpers 1978, Clémençon 2004)]. The conidiogenesis is probably holoblastic. Conidiophores (conidiogenous hyphae) hardly differentiated from vegetative hyphae, indiscrete, often arising from clamps, branched, each branch typically slightly swollen at the apex, with a clamp at some distance from the swelling, and developing a terminal blastoconidium. Blastoconidia light brown in mass [M. 6D(7-8)], arising from swollen parts of the conidiogenous hyphae, attached with a broad base, at first hyaline and thin-walled, brown-pigmented and thick-walled when mature (chlamydoconidia), often with a slightly flattened or truncated end, ovoid-ellipsoid, 5.0-8.0 × 3.5-5.0 µm in size, on average 7.05 × 4.52 µm, Q = (1.2-)1.4-1.7(-1.8), Qm = 1.56, smooth, IKI^-, CB^+, seceding rhexolytically and often with vestigial remnants of the subtending cell (clamped mother cell).

Teleomorphic stage (FIGS. 1B, 2A, 9). Basidioma short-lived, annual, below or close to the imperfect stage, polymorphic, effused-resupinate to reflexed -pileate, and then spathulate-flabelliform or reniform, 1-4(-5) cm wide, 3-6 mm thick, projecting 1.5-4 cm, always with a narrowed or resupinate base, single or sometimes occurring in loose imbricate clusters. Upper surface, when present, glabrous to slightly pubescent, white to light cream-grey [M. 5B(2-3)], zonate, soft, fragile, when fresh with small, round and hygrophanous flecks. Lower surface white, ochraceous-cream when dry, pores irregular, lacerate, angular-elongated to sinuose, 2-3(-4) per mm, with slightly denticulate edges. Context 1-2 mm thick, white, fibrillose; tubes whitish to cream, (1-)2-3(-4) mm long. Taste at first mild, slightly bitter after long mastication. Odour indistinct. Hyphal system monomitic, hyphae hyaline, 3.75-5.15 µm wide, colourless, thin- to slightly thick-walled, strongly interwoven, with frequent branching, especially from clamps, easily disarticulating, with abundant close to perforate (medallion) clamp connections and sometimes with clamp complexes of 2-3 close-set clamps. Pileus covering, a cutis made up of parallel arranged hyphae, up to 6 µm wide. Cystidia or other sterile hymenial elements absent. Basidia 4-spored, clavate, 15-17 × 5-6 µm, sterigmata up to 4 µm long, with a basal clamp. Basidiospores ellipsoid, 4-5 × 2-2.5(-3) µm, on average 4.15 × 2.15 µm, Q = 1.7-2.1, Qm = 1.9, flattened on one side, hyaline, thin-walled, smooth, usually uniguttulate, IKI^-, CB^-.



Figs. 3-8. *Postia ptychogaster*. Macro- and micromorphological characters of the conidiomata. **3.** Young conidioma. **4.** Chlamydoconidia formation. **5.** Old conidioma. **6.** Mature detached chlamydoconidia. In square, two chlamydoconidia with vestigial remnants of the subtending cell. **7.** Conidioma in section. **8.** Large clamp connection (medallion type). (All from collection GDOR 07101401), Scale bars 3,5,7 = 10 mm; 4,6,8 = 10 µm.

Habitat: saprotrophic, causing a brown cubical rot, on a dead, decayed trunk of *Abies alba*, fruiting together with *Hymenochaete cruenta* (Pers.) Donk.

Material examined: 14/10/2007, numerous specimens, Parco naturale della Collina di Superga, 500 m a.s.l. (Baldissero Torinese, Turin, Italy), leg. L. Latino, GDOR 07101401.

Discussion

Postia ptychogaster is a well-circumscribed species based on the effused-reflexed to pileate basidiomes, the absence of hymenial cystidia and the presence of a distinct and independent *Ptychogaster* anamorphic stage forming well-organized and large, pulvinate conidiomata. This imperfect stage always precedes the basidiome formation; conidiomata are far more frequent than basidiomes and are often found without the poroid stage (e.g. Domański 1972, Ryvarden & Gilbertson 1994, Clémençon 2002, Pieri & Rivoire 2006). In the Italian specimens, conidiomata were found strictly connected to the basidiomes. *P. ptychogaster* is reported as widespread in North and Central-Eastern Europe (Jülich 1984, Pegler & Saunders 1994, Ryvarden & Gilbertson 1994, Bondartseva 1998), although a rarely described and illustrated species, and was suspected to be endemic to Europe (Ryvarden & Gilbertson 1994). However, it has recently been found in Canada (Lamoureux 2007) and probably in the United States (UBC Botanical Garden Forums 2006). Our specimens represent the first collection of *P. ptychogaster* from Italy, and one of the rare reports from Mediterranean countries (South Europe). Well-known as a saprotrophic, brown-rot decay polypore, almost exclusively found on *Picea*, rarely on *Larix* and *Pinus*, and once noted on *Betula* (Domański 1972, Jülich 1984, Ryvarden & Gilbertson 1994, Niemelä 2005), it was collected in Italy on *Abies alba*.

As regard to the anamorphic stage, the genus *Ptychogaster* Corda, which encompasses the conidial stages of some species of *Postia*, is characterized by hyphae organized or not in a conidioma, provided with round medallion clamp connections at all septa and by one-celled conidia with a thick pigmented wall, born terminally, laterally or intercalary, mostly in branched chains and separated from the conidiogenous cell by a cross-wall, obovoid or broadly clavate, with a truncate, 2-3 µm wide base or truncate at both ends. The conidia are liberated by lysis of the mother (stalk) cell, remnants of which often remain attached to the base of the conidia (rhexolytic secession) (Ulbrich 1941, von Arx 1973, Sigler & Carmichael 1976, Stalpers 1984, 2000). The conidia form powdery masses. The genus *Ptychogaster* is morphologically closely related to *Sporotrichum*, which differs especially by the absence of clamp connections, and includes the anamorphs of *Laetiporus*, *Pycnoporellus* and *Phanerochaete*.

Our collection agrees fairly well with the descriptions and illustrations given by a number of authors (e.g. Domański 1972, Jahn 1970, 1979; Erkkilä & Niemelä 1986, Ryvarden & Gilbertson 1994, Bondartseva 1998, Stalpers 2000, Clémençon 2002, 2004; Bernicchia 2005, Niemelä 2005), except for one aspect of the conidiogenetic process: von Arx (1973), Sigler & Carmichael (1976) and Stalpers (1984, 2000), based on observations in pure culture, described conidia as formed in terminal clusters and/or in chains, whereas in our microscopic

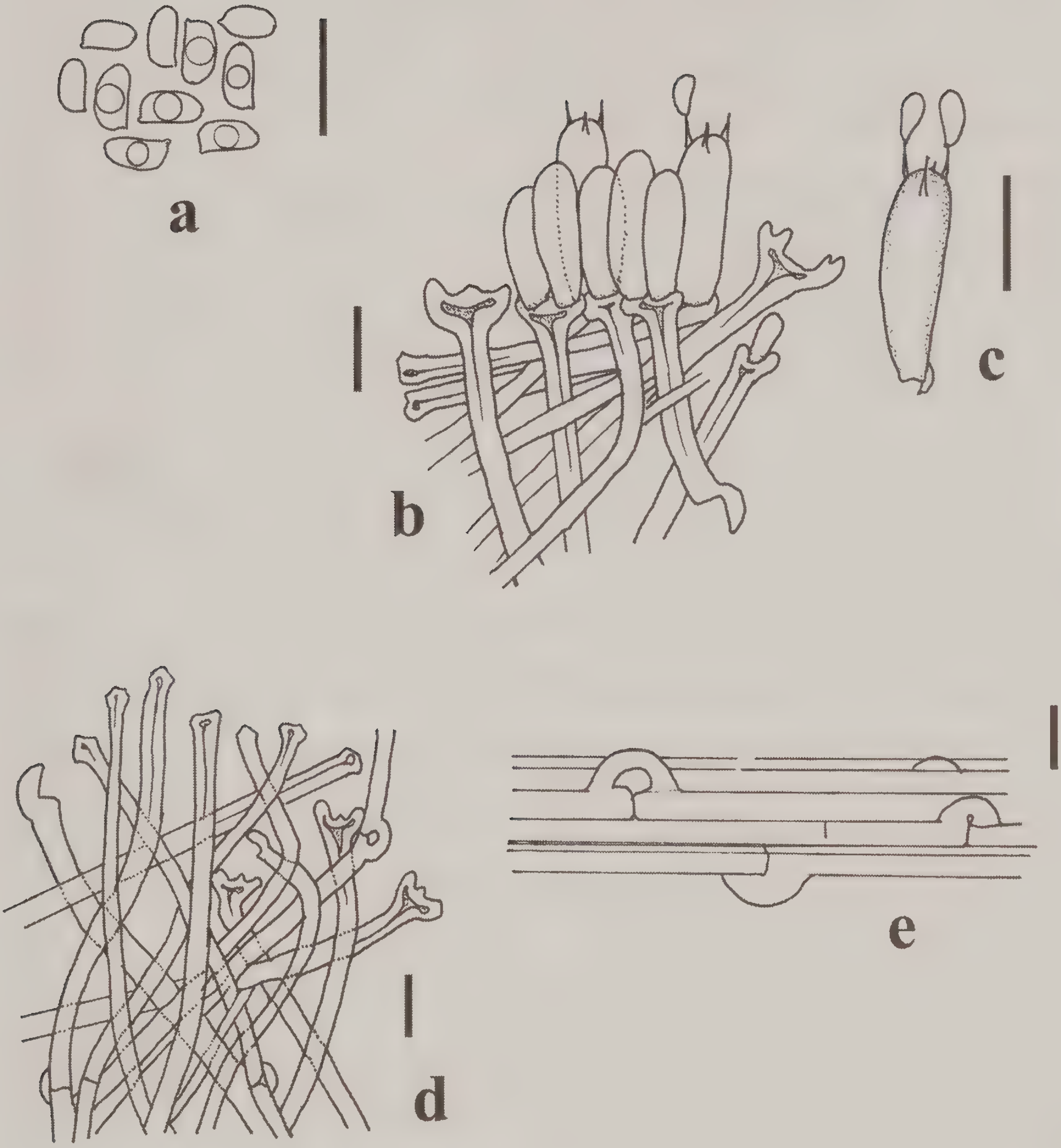


Fig. 9. *Postia ptychogaster*. Micromorphological characters of the basidiomes. a. Basidiospores. b. Subhymenial and tramal hyphae. c. Basidium. d. Contextual hyphae. e. Pileus covering hyphae. (All from collection GDOR 07101401). Scale bars = 10 µm. (Courtesy of Mido Traverso).

analysis of in natura conidiomata, only conidia borne singly and terminally are produced. It may be that the conidiogenesis pattern in cultures tends to be slightly different from that of hyphae growing on natural substrate. Regarding conidial measurements, reports range between 4.5-7 × 3.5-4.5 µm (Jahn 1970, 1979) to 5-10 × 3.5-7 µm (Ryvarden & Gilbertson 1994). Our measurements fits well with those of Fallahyan (1964; 5.5-6.5 × 5 µm), Bondartseva (1998; 5-8 × 3.5-5.5 µm), Stalpers [1978, 2000; (5.5-)6.5-8.5(-10) × 3.5-5(-5.5) µm] and Pieri & Rivoire [2006; 5-6.5(-7) × 4-5(-5.5) µm]. Some authors named the disseminula of *Ptychogaster* spp. as chlamydospores: in our opinion, these structures more correctly should be called conidia or chlamydoconidia, as asexual propagules formed after mitotic events (in agreement with David 1980 and Stalpers 2000).

P. rennyi (Berk. & Broome) Rajchenb. (anamorph: *Pt. citrinus* Boud.) is regarded as the closest taxon among the *Postia* species developing conidia in pure culture and/or in nature (Ryvarden & Gilbertson 1994, Gilbertson & Ristich 1997, Stalpers 2000, Pieri & Rivoire 2006): it differs in having strictly resupinate-effused, very brittle basidiomes and slightly smaller chlamydoconidia at the margin of the basidiomes or below the collapsed tubes, forming a yellow powdery mass.

Pt. rubescens Boud. was first described from France (Boudier 1887); it produces conidia 4-6.5 × 3-4.3 µm in size (Domański 1972, Ryvarden Gilbertson 1994, Pieri & Rivoire 2006) in pink, fragile, hemispherical conidiomata especially on conifer timber (Stalpers 2000, Pieri & Rivoire 2006). It was suspected to represent the anamorph of either *P. guttulata* (Peck) Jülich (Davidson et al. 1946, Fidalgo 1958, Domański 1972), *P. floriformis* (Quél.) Jülich (Erkkilä & Niemelä 1986, Pieri & Rivoire 1998, 2006; Stalpers 2000) or *Punctularia atropurpurascens* (Berk. & Broome) Petch (Stalpers 1978). In our opinion it is very close (if not identical), and hardly distinguishable from *Pt. fuliginoides*. In addition, these anamorph/teleomorph connections do not seem to have definitively been established so far.

The doubtful taxon *Multiporus chlamydoformans* Falck & O. Falck (1937) described as producing a whitish, poroid, effused basidiome, with hyphae up to 7 µm wide and ellipsoid spores 5 × 3-3.5 µm, is characterized by the presence of conidiomata of a brown *Ptychogaster* anamorph, with conidia ellipsoid to subcylindrical, 10-15 × 9-12 µm in size.

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Literature cited

Arx JA von. 1973. Further observations on *Sporotrichum* and some similar fungi. Persoonia 7(2): 127-130.

Bernicchia A. 2005. *Polyporaceae* s.l. Fungi Europaei, 10. Ed. Candusso. Alassio. Italy.

Bondartseva MA. 1998. Definitiorum Fungorum Rossiae. Ordo *Aphyllophorales*. Fasc. 2. Petropoli, Nauka.

Boudier E. 1887. Deux nouvelles espèces de *Ptychogaster* et nouvelle preuve de l'identité de ce genre avec les *Polyporus*. J. Bot. 1: 7-12.

Clémençon H. 2002. Le ventre plissé pulvérulent (*Ptychogaster pulverulentus*). Bull. Suisse Mycol. 80(5) : 188-190.

Clémençon H. 2004. Cytology and plectology of the Hymenomycetes. Biblioth. Mycol. 199: 1-488.

David A. 1980. Etude du genre *Tyromyces* sensu lato: repartition dans les genres *Leptoporus*, *Spongiporus* et *Tyromyces* sensu stricto. Bull. mens. Soc. linn. Lyon 49(1): 6-56.

Davidson RW, Christensen CM, Darley EF. 1946. *Polyporus guttulatus* and *Ptychogaster rubescens*. Mycologia 38(6) : 652-663.

Domański S. 1972. Fungi. *Polyporaceae* I (resupinatae), *Mucronoporaceae* I (resupinatae). Transl. from Polish (1965).

Erkkilä R, Niemelä T. 1986. Polypores in the parks and forests of the City of Helsinki. Karstenia 26(1): 1-40.

Falck R, Falck O. 1937. Die Ptychogasterfäule des Coniferenholz. Hausschwamm-forschungen 12: 1-61.

Fallahyan F. 1964. Étude culturale et anatomique de quelques Polypores conidiophorés à trame molle ou coriace. Thèse Faculté sc. Université Paris. 89 pp.

Fidalgo O. 1958. Studies on *Ptychogaster rubescens* Boud. The chlamydosporiferous form of *Polyporous guttulatus* Pk. Mycologia 50(6): 831-836.

Gilbertson R., Ristich S. 1997. *Oligoporus rennyi* in North America. Mycotaxon 64: 349-352.

Gilbertson RL, Ryvarden L. 1987. North American Polypores. Vol 2. Fungiflora, Oslo, Norway.

Holmgren PK, Holmgren NH. 1998. (continuously updated). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/ (accessed 18 November 2007).

Jahn H. 1970. Resupinate Porlinge, *Poria* s. lato, in Westfalen und im nördlichen Deutschland. Westfäl. Pilzbriefe 8 (3): 41-68.

Jahn H. 1979. Pilze die an Holz Wachsen. Busse, Herford, Germany.

Jülich W. 1984. Die Nichtblätterpilze, Gallertpilze und Bauchpilze. In Kleine Kryptogamenflora Band IIb/1. Gustav Fischer Verlag.

Kornerup A, Wanscher JH. 1978. Methuen Handbook of Colour. Ed. Eyre Methuen, London.

Lamoureux Y. 2007. Le Polypore oursin - *Postia ptychogaster* (Ludwig) Vesterholt. http://www.mycomontreal.qc.ca/portraits/ptychoga.htm (accessed 12 November 2007)

Niemelä T. 2005. Käävät – puiden sienet. (Polypores, lignicolous fungi. In Finnish, with English summary.) Norrlinia 13: 1-320.

Niemelä T, Kinnunen J, Larsson K-H,Schigel DS, Larsson E. 2005. Genus revisions and new combinations of some North European polypores. Karstenia 45(2): 75-80.

Onofri S, Bernicchia A, Filipello Marchisio V, Padovan F, Perini C, Ripa C, Savino E, Salerni E, Venturella G, Vizzini A, Zotti M, Zucconi L. 2005. Check-list dei funghi italiani, Parte I, *Basidiomycetes, Basidiomycota*. Carlo Delfino Editore, Sassari, Italy.

Pegler DN, Saunders EM. 1994. British poroid species formerly placed. in the genus *Tyromyces* (*Coriolaceae*). Mycologist 8: 24-31.

Pieri M, Rivoire B. 1998. *Postia inocybe* (David & Malençon) Jülich f. *inocybe* et f. *pileatus*, f. *nov*. Notes nomenclaturales sur le genre *Postia*. Bull. Soc. Mycol. Fr. 114(3): 19-33.

Pieri M, Rivoire B. 2006. A propos du complexe *Postia sericeomollis*. Bull. mens. Soc. linn. Lyon 75(3):113-133.

Ryvarden L, Gilbertson RL. 1994. European Polypores. Vol. 2. Fungiflora, Oslo, Norway.

Sigler L, Carmichael JW. 1976. Taxonomy of *Malbranchea* and some other hyphomycetes with arthroconidia. Mycotaxon 4(2): 349-488.

Spirin WA., Zmitrovich IV, Wasser SP. 2006. *Oligoporus balsameus* - rare Eurasian species plus notes on some related taxa. Mycotaxon 97: 73-82.

Stalpers JA. 1978. Identification of wood-inhabiting *Aphyllophorales* in pure culture. Studies in Mycology 16: 1-248.

Stalpers JA. 1984. A revision of the genus *Sporotrichum*. Studies in Mycology 24: 1-105.

Stalpers JA. 2000. The genus *Ptychogaster*. Karstenia 40: 127-140.

UBC Botanical Garden & Centre for Plant Research, forums. 2006. My orange buddy is back. http://www.ubcbotanicalgarden.org/forums/showthread.php?t=20508 (accessed 18 November 2007)

Ulbrich E. 1941. Über die Gattung *Ceriomyces* Corda 1837 (*Ptychogaster* Corda 1838), die *Ptychogasteraceae* Falck 1939 und die *Ceriomyces*-(*Ptychogaster*)-Fäule an Nadelholz. Notizblatt des Königl. botanischen Gartens und Museums zu Berlin 15(4): 572-594.

Vesterholt J, Knudsen H. 1997. *Postia* Fr. In: Nordic Macromycetes Vol. 3 – Heterobasidioid, Aphyllophoroid and Gastromycetoid *Basidiomycetes*, Hansen L & Knuden H (eds.). Nordsvamp, Copenhagen, pp. 234-237.

Wei YL, Dai YC. 2006. Three new species of *Postia* (*Aphyllophorales*, *Basidiomycota*) from China. Fungal Divers. 23: 391-402.

Yao Y-J, Pegler DN, Chase MW. 1999. Application of ITS (nrDNA) sequences in the phylogenetic study of *Tyromyces* s.l. Mycol. Res. 103(2): 219-229.

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Chalciporus africanus, a new bolete species from Africa

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Abstract — A new bolete species, *Chalciporus africanus*, has been discovered in the rain forest of Cameroon. It is the first representative of its genus to be described from the African continent.

Key words — *Boletales*, taxonomy

Introduction

The present knowledge of African boletes refers to about 150 species collected from only a few localities. Comprehensive contributions towards the knowledge of the Central African taxa were published by Heinemann (1951, 1953, 1954a, b, 1955, 1960, 1964a, b, 1966), Heinemann & Rammeloo (1980, 1982, 1983a, b, 1986a, b, 1987, 1989), Rammeloo & Heinemann (1982, 1987, 1988, 1990, 1995) and Rammeloo et al. (1988). East African taxa were reported by Watling & Turnbull (1992, 1994).

Several genera of the *Boletaceae* sensu Singer (1986) have not been recorded in Africa, notably, *Chalciporus* Bataille. Despite this genus having representatives in temperate northern hemisphere, tropical and sub-tropical regions, it was surprising that no records occurred in Africa. Macro-morphologically *Chalciporus* is well characterised by pink or reddish hymenophore, the presence of yellow mycelium at the base of its stipe (which lacks a reticulum or asperulation) and the absence of velar remnants on both cap and stipe. The cystidia are usually conspicuous, the smooth spores are elongated or short ellipsoid. The spore prints typically lack olive tinges. Clamp connections are absent and in fresh specimens the mediostratum of the hymenophore is often tinged red.

During a collecting trip to the Dja Forest Reserve in the Eastern Province of Cameroon, a new species of *Chalciporus* was gathered on a river edge under *Uapaca guineensis*.

Materials and methods

The macroscopic description is based on field notes and photographs. Codes (between square brackets) and names for colours correspond with the Methuen Handbook of Colour (Kornerup & Wanscher 1983).

The microscopic structures were observed in a 1% Congo-red solution and Melzer's reagent. Measurements were performed using an Olympus BX51 light microscope, with digital camera and AnalySIS® Five imaging software (Soft Imaging System GmbH). Mean values (in italics) ± 1.96 × standard deviations, and minimum-maximum values (between brackets) are given for all microstructures and derived parameters (length/width ratios). For the statistical data 75 basidiospores and 10 basidia and cystidia were measured. The holotype material and the additional collections are deposited at the National Botanic Garden of Belgium's herbarium 'BR' (abbreviation following Holmgren et al. 1990).

Taxonomy

Chalciporus africanus Degreef & De Kesel, **sp. nov.** FIGURES 1 & 2
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Pileus 10–30 mm, cinnamomeus dein suffusco-rufus, aliquantulus lurido-maculatus, siccus, subtomentosus. Tubi adnati dein subdecurrentes vel decurrentes, pallidi-flavi dein rubri. Pori concolores ut ad instar tuborum, paulatim rufescentes ab centro. Stipes 30–55 x 3–5 mm, cylindricus vel subclavatus, griseo-croceus sed rubello-fuscus infra tubos, ad apicem minute furfuraceus, mycelium basale flavum. Caro crassa, albida in centro pilei et in basim stipitis, alibi rubella, immutabilis. Basidiosporae (7.1–10.3 × 3.3–4.2 µm) ellipsoideae vel fusoideae, leves, pallido-melleae, inamyloideae. Basidia (30–38× 7–9 µm) cylindrica vel subclavata, tetraspora. Pleurocystidia (35–57× 7–10 µm) cylindracea, anguste lageniformia vel anguste clavata. Cheilocystidia (35–62 × 11–16 µm) pedunculata vel lageniformia. Pileipellis ex hyphis haud gelatinosis trichodermium formantibus. Fibulae desunt.

HOLOTYPUS: AFRICA, CAMEROON, Eastern Province, Dja Forest Reserve, Somalomo, 7.IV.2007, *Degreef* 517 (BR).

PILEUS 10–30 mm in diameter, hemispherical to sub-umbonate, becoming plano-convex; cinnamon [6D6] then brownish red [9C6] to dull red [9B4] with sparse pale yellow [3A3] stains; surface dry, flocculose; margin obtuse, straight; context thick especially at the centre of the pileus (up to 10 mm), white to cream-colour [4A3] with pale red to pink [10A3] shades towards the stipe. TUBES sub-decurrent then decurrent, up to 5 mm long, light yellow [4A4] then reddish brown [9E6] to oxblood red [9E7]. PORES irregular, up to 1 mm in diameter; concolorous with the tubes, progressively becoming red from the centre to the margin when aging, pores at the margin often paler. STIPE 30–55 × 3–5 mm, central, cylindrical to sub-clavate with base up to 10 mm

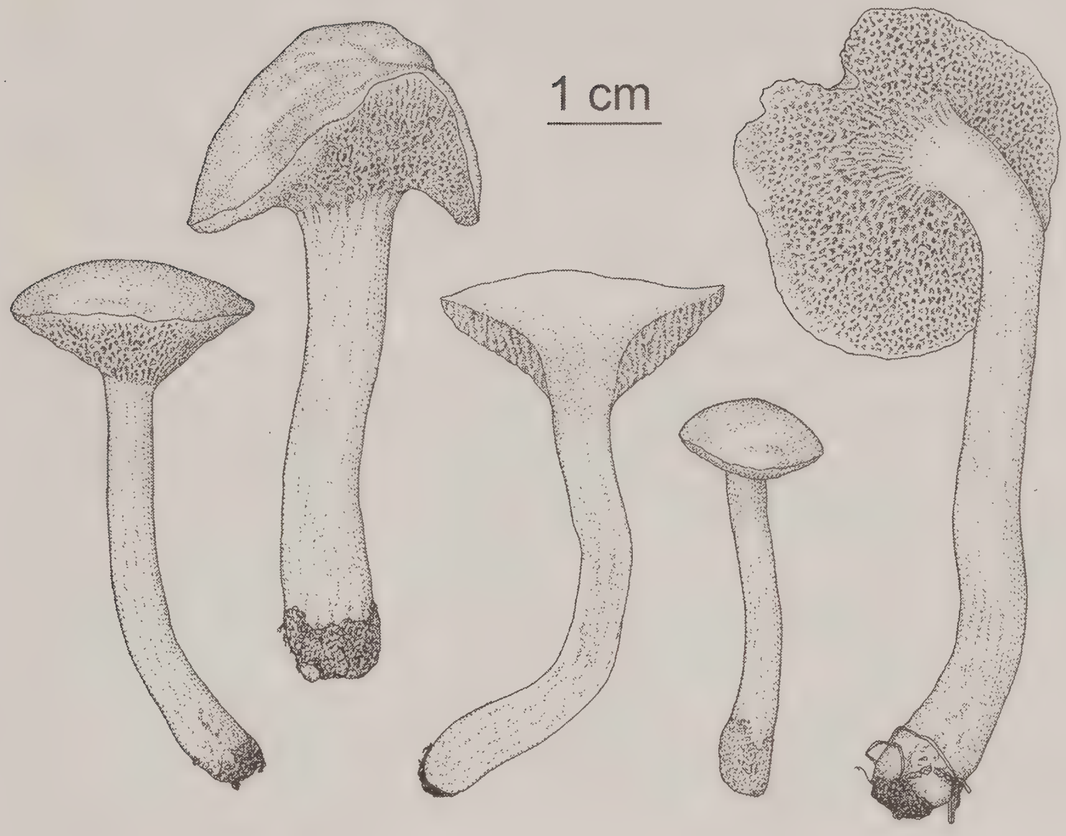

Fig. 1. *Chalciporus africanus* (*Degreef* 517, holotype). Basidiomes.

wide; solid, fibrous; reddish brown [9E6] immediately below the tubes, greyish orange [5B4] elsewhere, with cinnamon to cognac brown [6D6–6E7] floccules in its upper third. Odour agreeable, weak. TASTE mild. SPORE PRINT dark blond [5D4]. MYCELIUM yellow.

BASIDIOSPORES (7.1–)7.5–*8.7*–9.9(–10.3) × (3.3–)3.4–*3.8*–4.2(–4.2) µm, (l/w = (1.9–)1.97–*2.31*–2.65(–2.7)), broadly elliptical to broadly fusiform, with a very moderate suprahilar depression, weakly pigmented (under the microscope), uni- or biguttulate, smooth, inamyloid. BASIDIA (30–)29.1–*33.5*–37.9(–38) × (7–)7.1–*8.3*–9.5(–9) µm, cylindrical to narrowly clavate, hyaline or containing small granules while immature, mostly 4-spored. PLEUROCYSTIDIA (35–)37.3–*49.5*–61.7(–57) × (7–)6.7–*8.5*–10.3(–10) µm, cylindrical to narrowly lageniform, sometimes narrowly clavate, emergent, thin-walled, concolorous with the hymenium, hyaline, without crystals or incrustations. CHEILOCYSTIDIA (35–)32.2–*43.2*–54.2(–62) × (11–)10.5–*13.1*–15.7(–16) µm,

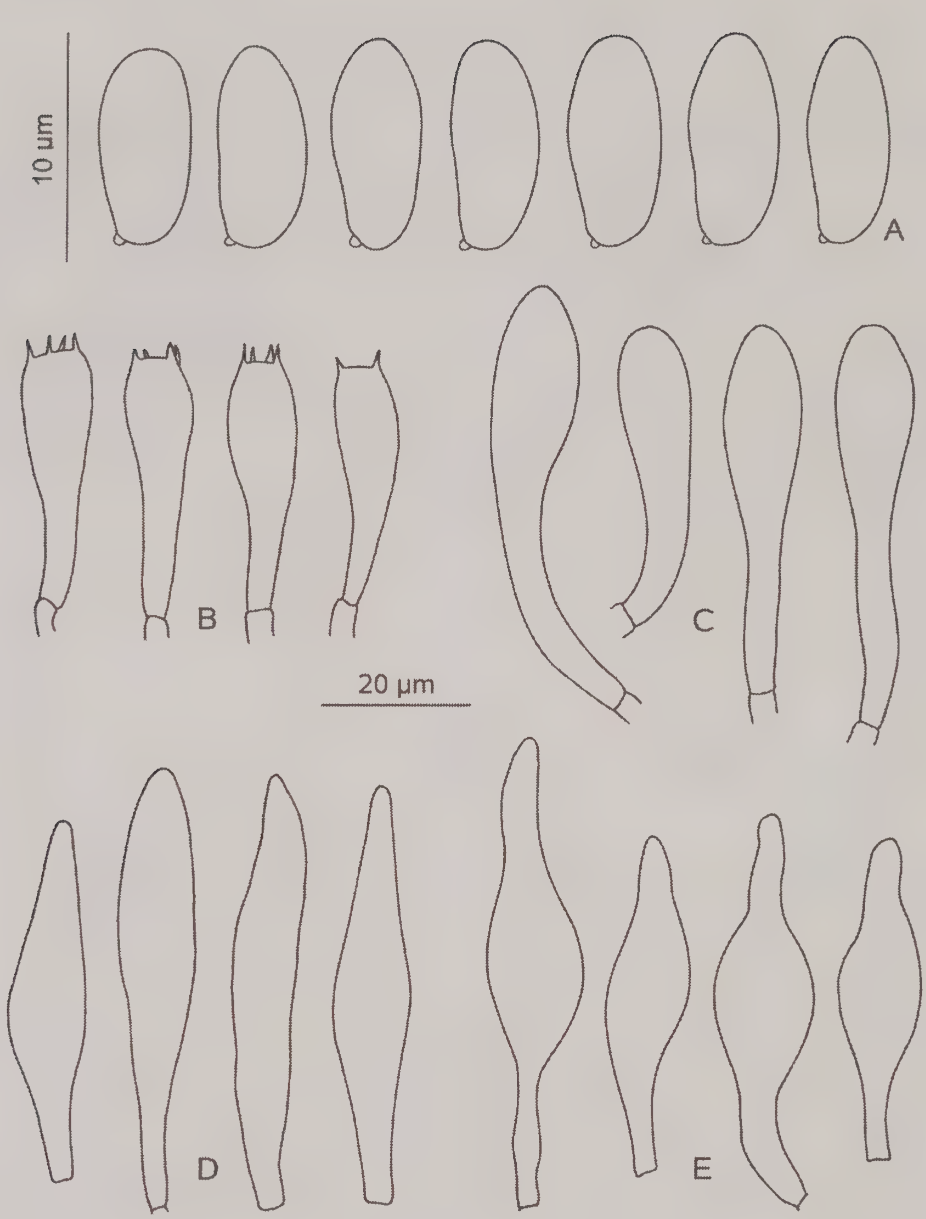

Fig. 2. *Chalciporus africanus* (*Degreef* 517, holotype).
A. basidiospores; B. basidia; C. caulocystidia; D. pleurocystidia; E. cheilocystidia.
(A: vertical scale bar; B-E: horizontal scale bar).

narrowly lageniform to lageniform, sometimes pedunculate, emergent, thin-walled, hyaline, without crystals or incrustations. Pileipellis a trichoderm, collapsing into a cutis, 50–70 µm thick, consisting of parallel, pigmented, non-amyloid, thin-walled hyphae, 40–80 × 5–7 µm; terminal cells narrowly clavate to clavate, 20–30 × 10–12 µm, with scattered incrustations; no mucilagineous layer. Stipitipellis composed of hyaline, thin-walled hyphae, 20–90 × 5–10 µm; caulocystidia from floccules narrowly clavate, (38–)33.6–*46.4*–59.2(–58) × (7–)5.6–*8.8*–12(–11) µm. TRAMA composed of hyaline or reddish, thin-walled hyphae, up to 14 µm wide, mostly parallel or very slightly divergent from the mediostratum, oleiferous hyphae absent. CLAMP CONNECTIONS absent.

ECOLOGY AND DISTRIBUTION: Rain forest, scattered along river's edge, growing under the tree *Uapaca guineensis* (*Euphorbiaceae).*

SPECIMENS EXAMINED– CAMEROON. EASTERN PROVINCE, DJA FOREST RESERVE, near Somalomo, N03°23'39" E12°43'25". *Degreef* 506, 6.IV.2007. Ibid. *Degreef* 516, 7.IV.2007. Ibid. *Degreef* 517, 7.IV.2007 (HOLOTYPE-BR).

COMMENTS — *Chalciporus africanus* is similar to the temperate *C. rubinus* (W.G. Sm.) Singer but differs due to its larger and more elongated spores, unchanging context and prominent reddish colour of its cap. As a consequence, *C. africanus* bridges the generic difference between *Chalciporus* and *Rubinoboletus* Pilát & Dermek. The close relationship between *C. africanus* and *C. rubinus* confirms Singer's statement that *Boletus rubinus* W.G. Sm. is a good species of *Chalciporus*, making *Rubinoboletus* a synonym of *Chalciporus* (Singer 1986). The genus *Rubinoboletus* was created to accommodate *C. rubinus* based solely on its globose spores (Pilát & Dermek 1969). We think that all globose-spored taxa subsequently combined in, or described under, *Rubinoboletus* should be placed elsewhere. In this context, sub-globose spores are to be expected in any alliance of elongated spores.

Macroscopically *Chalciporus africanus* is similar to the temperate and widely distributed *C. piperatus* (Bull.: Fr.) Bataille. The latter, however, is a much taller species with a peppery taste, longer (average 9.8 µm) spores, and incrusted cystidia (Muñoz 2005, see fig. 33, p. 275).

Chalciporus africanus is possibly also close to the tropical *Boletus* (*Xerocomus*) *rubriporus* Corner from Malaysia (Corner 1972), a species that now resides in *Chalciporus* (Singer 1986). *C. rubriporus* and *C. africanus* share a similar general habitus and pileipellis arrangement of loosely interwoven hyphae that are not arranged in a pile. *C. rubriporus*, however, has larger spores, more elongate cystidia, and discolouring pores and tubes.

Singer (1986) stated that *Chalciporus* has 'erratic' mycorrhizal associations, i.e. a wide range of hosts. *Chalciporus* is known to associate with *Pinus*, *Fagus*, *Quercus*, *Betula*, *Nothofagus* and *Cistus*. *Chalciporus africanus* however, seems to be specific as it was exclusively found under the endemic *Uapaca guineensis*, a large tree typically growing along rivers and rivulets. In Africa, this host is frequently reported to be associated with many other ectomycorrhizal boletes (Thoen 1993), but taxa of *Chalciporus* had not previously been recorded.

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Literature Cited

Corner EJH. 1972. *Boletus* in Malaysia. Singapore, Botanic Gardens.

Heinemann P. 1951. Champignons récoltés au Congo Belge par Madame M. Goossens-Fontana 1. *Boletineae*. Bull. Jard. Bot. Etat, Brux. 21(3-4): 223-346.

Heinemann P. 1953. Champignons récoltés au Congo Belge par Madame M. Goossens-Fontana 1. *Boletineae*, note complémentaire. Bull. Jard. Bot. Etat, Brux. 23(1-2): 73-76.

Heinemann P. 1954a. Note sur les *Boletineae* africaines. Bull. Jard. Bot. Etat, Brux. 24(2): 113-120.

Heinemann P. 1954b. *Boletineae*. Fl. Icon. Champ. Congo. Fasc. 3.: 51-80.

Heinemann P. 1955. Champignons récoltés au Congo Belge par Madame M. Goossens-Fontana 1. *Boletineae*, note complémentaire 2. Bull. Jard. Bot. Etat, Brux. 25(2): 169-181.

Heinemann P. 1960. Notes sur les *Boletineae* africaines 2. Bull. Jard. Bot. Etat, Brux. 30(1): 21-24.

Heinemann P. 1964a. *Boletineae* du Katanga. Bull. Jard. Bot. Etat, Brux. 34(4): 425-478.

Heinemann P. 1964b. Notes sur les *Boletineae* africaines 3. Bull. Jard. Bot. Etat, Brux. 34(2): 269-272.

Heinemann P. 1966. *Hygrophoraceae*, *Laccaria* et *Boletineae* II (complément). Fl. Icon. Champ. Congo. Fasc. 15: 279-308.

Heinemann P, Rammeloo J. 1980. *Gyrodontaceae* p.p. (*Boletineae*). Fl. Ill. Champ. Afr. Centr. Fasc. 7: 128-131.

Heinemann P, Rammeloo J. 1982. Observations sur le genre *Phlebopus* (*Boletineae*). Mycotaxon 15: 384-404.

Heinemann P, Rammeloo J. 1983a. Combinaisons et taxons nouveaux de *Gyrodontaceae* (*Boletineae*). Bull. Jard. Bot. Nat. Belg. 53(1-2): 294-297.

Heinemann P, Rammeloo J. 1983b. *Gyrodontaceae* p.p. (*Boletineae*) . Fl. Ill. Champ. Afr. Centr. Fasc. 10: 173-198.

Heinemann P, Rammeloo J. 1986a. *Phylloporus gomphidioides* sp. nov. du Burundi (*Xerocomaceae*, *Boletineae*). Bull. Jard. Bot. Nat. Belg. 56: 224-225.

Heinemann P, Rammeloo J. 1986b. *Paxillaceae* (*Boletineae*). Fl. Ill. Champ. Afr. Centr. Fasc. 12: 263-271.

Heinemann P, Rammeloo J. 1987. *Phylloporus* (*Boletineae*). Fl. Ill. Champ. Afr. Centr. Fasc. 13: 277-309.

Heinemann P, Rammeloo J. 1989. *Suillus* (*Boletaceae*, *Boletineae*) et *Tubosaeta* (*Xerocomaceae*, *Boletineae*). Fl. Ill. champ. Afr. Centr. Fasc. 14: 313-335.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I: Herbaria of the World. 8th ed. Bronx, New York Botanical Garden.

Kornerup A, Wanscher JH. 1983. Methuen Handbook of Colour. 3rd ed. London, Eyre Methuen.

Muñoz JA. 2005. *Boletus* s.l. (excl. *Xerocomus*). Fungi Europaei. Alassio. Edizioni Candusso.

Pilát A., Dermek A. 1969. *Rubinoboletus*, genus novum *Boletacearum*. Ceská Mykologie 23(2): 81-82.

Rammeloo J, Heinemann P. 1982. Les bolets à sétules. Bull. Jard. Bot. Nat. Belg. 52: 477-482.

Rammeloo J, Heinemann P. 1987. Novitates generis *Phyllopori* (*Boletineae*). Bull. Jard. Bot. Nat. Belg. 57: 272-274.

Rammeloo J, Heinemann P. 1988. Novitates generis *Tubosaetae* (*Boletineae*). Bull. Jard. Bot. Nat. Belg. 58: 265-266.

Rammeloo J, Heinemann P. 1990. Taxa nova *Boletineae*. Bull. Jard. Bot. Nat. Belg. 60: 416.

Rammeloo J, Heinemann P. 1995. Taxa nova *Boletineae* africanae. Bull. Jard. Bot. Nat. Belg. 64: 215-218.

Rammeloo J, Heinemann P, Rullier E. 1988. L'ornementation sporale des *Xerocomaceae*. Bull. Jard. Bot. Nat. Belg. 58(3-4): 513-534.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4th ed. Koenigstein, Koeltz Scientific Books.

Thoen D. 1993. Looking for ectomycorrhizal trees and ectomycorrhizal fungi in Tropical Africa. In Isaac et al. (eds) Aspects of Tropical Mycology: 193-205. Cambridge. Cambridge University Press.

Watling R, Turnbull E. 1992. Boletes from South and East Central Africa 1. Edinb. J. Bot. 49(3): 343-361.

Watling R, Turnbull E. 1994. Boletes from South and East Central Africa 2. Edinb. J. Bot. 51(3): 331-353.

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Diversity of nivicolous myxomycetes in the Gorce mountains – a low-elevation massif of the Western Carpathians

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Abstract — Nivicolous myxomycetes constitute an ecologically well-defined group of organisms requiring the particular set of environmental conditions that occur in mountain habitats with long-lasting winter snow cover. In Europe, relatively complex data sets relating to this group are available only from the Alps and mountains of the Iberian peninsula, whereas there is almost no data from other mountainous areas. In order to contribute to the knowledge of the diversity and distribution of this group in the central European mountains, we carried out the first comprehensive study in the Carpathians, one of the major parts of the European mountain system. A survey of the diversity of nivicolous myxomycetes was conducted in a low-elevation area of the Gorce Mountains (Western Carpathians, Poland), including fieldwork during six seasons. We recorded 18 species, ten of which are reported for the first time from Poland. *Diderma niveum, Lepidoderma chailletii* and *Lamproderma ovoideum* repeatedly occurred very abundantly and represented an important element in the spring phenological aspect of glades and shrub communities of the study area.

Key words — biogeography, taxonomy

Introduction

Nivicolous myxomycetes constitute an ecologically well-defined group of organisms requiring a particular set of environmental conditions that occur in mountain habitats with long-lasting winter snow cover, at the edge of melting snow in spring. There is an increasing body of data relating to the world distribution of this group, but it is still so scarce and unequally distributed that a major obstacle remains with respect to approaching general problems. In Europe, relatively complex data sets are available, mainly from the Alps (e.g. Meylan 1931, 1932; Schinner 1982, Cochet & Bozonnet 1984, Bozonnet et al. 1991, Meyer 1986, Meyer et al. 1996, Neubert et al. 1993, 1995, 2000; Singer et al. 2001ab, Poulain et al. 2002a) and from the mountains of the Iberian peninsula (e.g. Sánchez et al. 2002, Moreno et al. 2003a, Lado 2004, Lado et al. 2005). Other mountain regions have not been investigated thus far, or only incidentally collected data are available (e.g. Ronikier & Ronikier 2007). Systematic regional investigations are needed to develop a better understanding of the biogeography and ecology of this group.

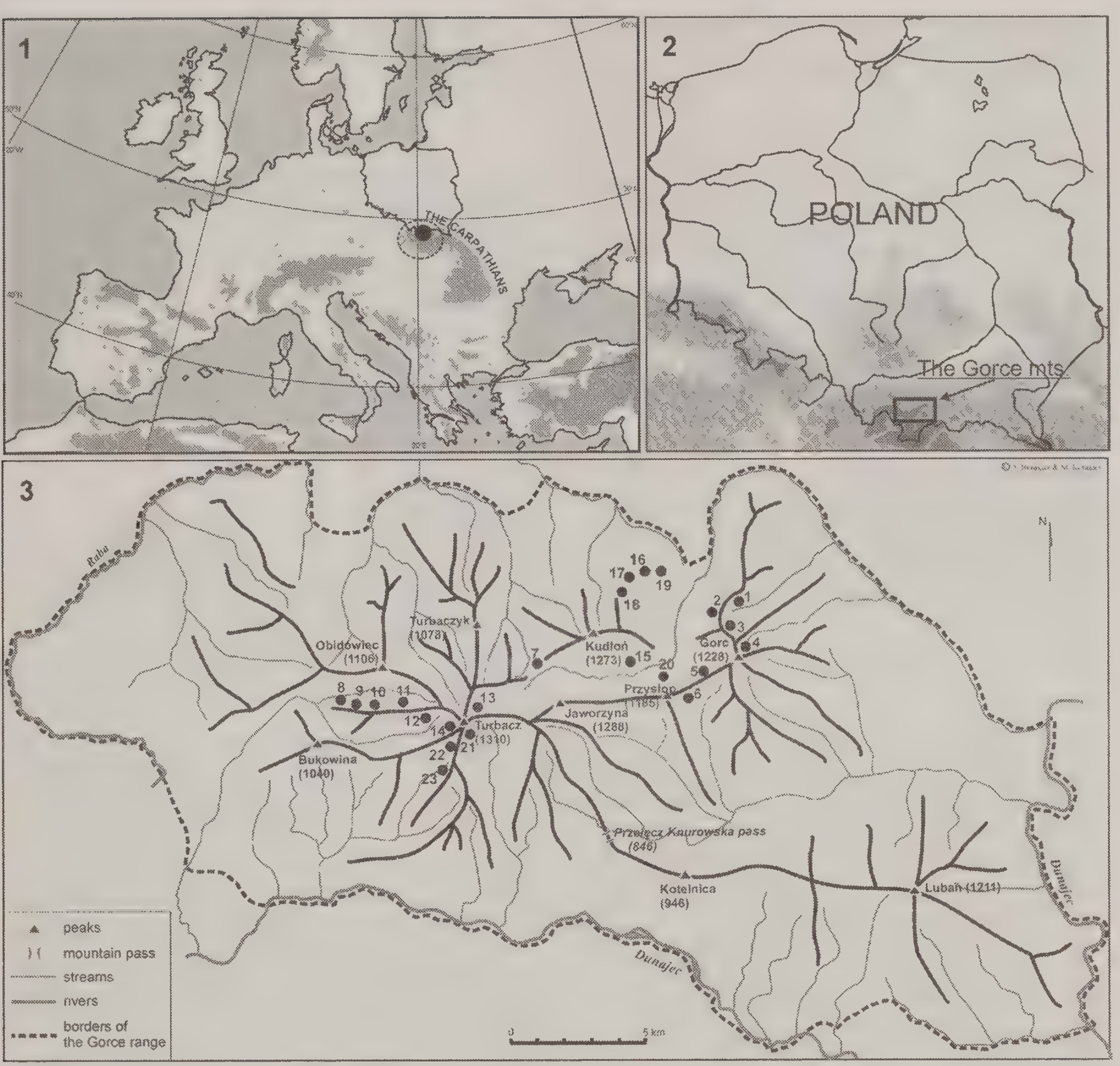
The Carpathians form one of the major elements of the European alpine system (Ozenda 1985), but data concerning nivicolous myxomycetes from this range are very scarce. Only seven strictly nivicolous species have been reported thus far from incidental observations in the Western Carpathians. They are *Diderma alpinum*, *D. niveum*, *Lamproderma ovoideum*, *L. sauteri*, *Lepidoderma chailletii*, *Physarum albescens* and *Trichia alpina* (Wichanský 1962, 1963; Drozdowicz 1985, 1988, 1995; Komorowska & Drozdowicz 1996). The first observations have recently been reported from the Eastern Carpathians (Drozdowicz 1997, 2000; Krivomaz et al. 2005).

Herein, we present the first more complete report from a mountain massif in the Carpathians. Based on several field prospects, we investigated the diversity of nivicolous myxomycetes in the Gorce Mountains, a model lower-mountain massif representative of the greater part of the Western Carpathians. Specific aims of this study were (1) to outline the diversity of nivicolous slime moulds in the Western Carpathian massif and (2) to make a contribution to the knowledge of the distribution of this group in the central European mountains, an area very poorly investigated in this respect.

Materials and methods

The study area

The Carpathian arch is divided into three main biogeographical units; these are the Western, Eastern and Southern Carpathians. The Gorce Range forms a part of the Western Carpathians (Figs. 1-3). These mountains cover an area of approximately 550 km^2 and represent a typical landscape of this part of the Carpathians, dominated by lower-mountain areas built of flysch (Figs. 4-5). As one of the most representative parts of the Western Carpathians, a large part of the Gorce massif is protected as a national park. The Gorce Mountains reach an elevation of 1310 m a.s.l., but only about 10% of the massif exceeds an elevation of 1000 m. The mean temperature of the year in the highest areas is estimated at 2–3°C, while the mean temperature of January is -6.2°C. The snow cover is usually present from November to April, up to 170 days on northern exposures, where patches of snow still persist in May (Kornaś 1955, Miczyński 2006). Two elevational vegetation zones can be distinguished in the mountains: the lower montane belt with beech, fir and spruce forests (up to 1150–1200 m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borders of the Gorce range
0
5 km

Figs. 1-3. Location of the area of research. 1. Location of the Carpathians in Europe; Western Carpathians embedded with dashed line. 2. Location of the Gorce massif. 3. The Gorce Range; dots – localities of sampling, numbers refer to those in Table 1.

a.s.l.) and the upper montane belt dominated by spruce forests (Kornaś 1955). Natural treeless (subalpine and alpine) vegetation is absent from the massif due to moderate elevations, but the presence of numerous anthropogenic semi-natural glades, due to multicentennial pastoral husbandry, is a characteristic feature of this area, increasing the landscape diversity (Figs. 4-6). Changes in land use during the last decades, especially the abandonment of grazing and hay-making, launched transformation of open glades into shrub communities with *Vaccinium myrtillus*, followed by expansion of young trees (Figs. 5-6). All of these conditions form a potentially diverse mountain environment for nivicolous myxomycetes, but not characterized by subalpine or alpine habitat features (Figs. 6-9).

Figs. 4-9. Area of research. 4, 5. Typical landscape of the Gorce massif with spruce montane forest and abandoned pastures with young trees in succession. 6-9. Localities of sampling: 6. mountain meadow, 7. forest interior, 8. small clearing by path, inside forest, 9. shrub vegetation inside forest.

Table 1: Localities of collections in the Gorce mountains (Western Carpathians).

N°	Locality, habitat, date of collection, collector	Geographic coordinates	Elevation
[1]	Upper part of the Głębieniec valley, N ridge of the Gorc Mtn., E slope, by a path, shrubs with *Rubus* sp.; 18 Apr 2004; *leg. AR, MR*	20°14'47" E 49°34'50" N	1030 m
[2]	Upper part of the Głębieniec valley, N ridge of the Gorc Mtn., E slope, about 200 m N from the glade Świnkówka, steep slope in beech forest, shrubs with *Rubus* sp.; 18 Apr 2004; *leg. AR, MR*	20°14'24" E 49°34'32" N	1060 m

[3]	NW part of the glade Gorc Kamienicki (N ridge of the Gorc Mtn.), meadow; 18 Apr 2004; *leg. AR, MR*	20°14’56” E 49°34’17” N	1130–1150 m
[4]	S part of the glade Gorc Kamienicki (N ridge of the Gorc Mtn.), meadow; 18 Apr 2004; *leg. AR, MR*	20°15’07” E 49°34’03” N	1150 m
[5]	Ridge between the Gorc Mtn. and the Przysłop Mtn., S slopes, the glades Chyzniocka and Przysłop Dolny, meadow; 18 Apr 2004; *leg. AR, MR*	20°13’19” E 49°33’13” N	1080–1090 m
[6]	Ridge between the Gorc Mtn. and the Przysłop Mtn., S slopes, the glade Polana Przysłop Dolny, meadow; 18 Apr 2004; *leg. AR, MR*	20°12’45” E 49°33’01” N	1150 m
[7]	Ridge from the Borek pass to the Kudłoń Mtn., the glade Przysłopek (S slopes), meadow; 18 Apr 2004; *leg. AR, MR*	20°09’21” E 49°33’55” N	1100 m
[8]	Ridge of the Średni Wierch Mtn., above the village Obidowa, below the glade Stusy, degraded beech forest with spruce; 13 May 2006; *leg. AR, MR*	20°02’32” E 49°32’52” N	880 m
[9]	Ridge of the Średni Wierch Mtn., above the village Obidowa, surroundings of the glade Stusy, meadow; 13 May 2006; *leg. AR, MR*	20°02’40” E 49°32’48” N	950 m
[10]	Ridge of the Średni Wierch Mtn., above the village Obidowa, the glade Tynowe, meadow; 13 May 2006; *leg. AR, MR*	20°03’19” E 49°32’49” N	1020 m
[11]	Ridge of the Średni Wierch Mtn., above the village Obidowa, small glades close to the Średni Wierch Mtn., meadow; 13 May 2006; *leg. AR, MR*	20°03’19” E 49°32’49” N	1090 m
[12]	Ridge of Turbacz Mtn., the Rozdziele Mtn., at the red tourist trail, spruce forest; 13 May 2006; *leg. AR, MR*	20°05’52” E 49°32’57” N	1190 m
[13]	Ridge of Turbacz Mtn., surroundings of the glade Turbacz, N slopes, meadow; 13 May 2006; *leg. AR, MR*	20°06’36” E 49°32’50” N	1230 m
[14]	Turbacz Mtn., summital area, spruce forest (upper montane belt); 13 May 2006; *leg. AR, MR*	20°06’41” E 49°32’34” N	1280–1310 m
[15]	Range of Kudłoń Mtn., below the glade Stawieniec, edge of forest; 21 Oct 2006; *leg. AC*	20°11’34” E 49°33’45” N	1000 m
[16]	NE ridge of the Kudłoń Mtn., the glade Jaworzynka, meadow; 20 Apr 1983; *leg. AD*	20°12’25” E 49°35’15” N	1020 m
[17]	NE ridge of the Kudłoń Mtn., the glade Podskały, meadow; 20 Apr 1983; *leg. AD*	20°11’53” E 49°35’12” N	1000 m
[18]	NE ridge of the Kudłoń Mtn., the glade Adamówka, meadow; 20 Apr 1983; *leg. AD*	20°11’29” E 49°34’43” N	1050 m
[19]	NE ridge of the Kudłoń Mtn., E edge of the glade Jaworzynka, meadow; 4 Apr 1981; *leg. AD*	20°12’43” E 49°35’17” N	990 m
[20]	Kamienica valley, the Przysłop Mtn.; 5 May 2006; *leg. AC*	-	-
[21]	Turbacz Mtn., vicinity of the refuge; 25 May 2001; *leg. AD*	20°07’10” E 49°32’34” N	1270 m
[22]	S ridge of the Turbacz Mtn., the glade Długie Młaki, meadow; 19 May 2000; *leg. AD*	20°06’28” E 49°32’03” N	1200 m
[23]	S ridge of the Turbacz Mtn., the glade Rusnakowa, meadow; 19 May 2000; *leg. AD*	20°06’19” E 49°32’02” N	1150 m

Collector abbreviations: AC – Andrzej Chlebicki; AD – Anna Drozdowicz; AR – Anna Ronikier; MR – Michał Ronikier.

Field work and methods of analysis

Field collecting was made in spring in 1981, 1983, 2000, 2001, 2004 and 2006, in various sites of the Gorce Mountains, mainly in the area of the Gorce National Park. Single collections made in 2006 and kindly provided by A. Chlebicki were also taken into account. In total, 23 sites were investigated (Table 1, Fig. 3). Collections were made in open places such as glades and meadows, close to the melting snow, as well as inside forest, at snow patches or in places where the snow disappeared. All collections were deposited in KRAM or KRA, with some duplicates in MA-Fungi and in the private herbarium of Marianne Meyer.

Standard methods used in the taxonomy of myxomycetes were applied to study the collected material. Analysis of microscopic characters and all microscopic measurements were performed on permanent preparations fixed in Hoyer's medium; measurements were made under the oil immersion ×100 objective. For each collection 20 spores were measured; the reported spore size does not include spore ornamentation. The scanning electron microscopy (SEM) observations were carried out with a Hitachi S-4700 microscope, using 10 kV voltage and working distance of about 12 mm. The material was prepared in a sequence of acetone dilutions (50% – 100%) followed by the critical point drying procedure and coating with gold.

Nomenclature used for myxomycetes follows Hernández-Crespo & Lado (2005; http://www.nomen.eumycetozoa.com).

Results

In total, 148 collections were gathered in the Gorce Mountains within the framework of this study. Eighteen species were identified from this material, all but *Didymium dubium* considered to be strictly nivicolous (Bozonnet et al. 1991). Ten taxa are new to Poland; they are marked with an asterisk "*" in the list below. Numbers of collection sites given in bold in brackets refer to TABLE 1.

Diderma alpinum (Meyl.) Meyl.

SPECIMENS EXAMINED. [**10**], on stems of *Rubus* sp., KRAM M-1157, duplicate in herb. Marianne Meyer; [**18**], on grass culms, mosses, beech leaves and other plant remnants, KRA MYXO-520; KRA MYXO-523; [**19**], on grass culms or plant remnants, KRA MYXO-525; KRA MYXO-526.

*****Diderma globosum*** var. ***europaeum*** Buyck

SPECIMENS EXAMINED. [**2**], on fallen twigs and leaves of *Fagus sylvatica*, fallen twigs and needles of *Picea abies*, on stems of *Rubus* sp., KRAM M-1151, duplicate in MA-Fungi; [**4**], on stems of *Rubus* sp., KRAM M-1149.

Diderma niveum (Rostaf.) T. Macbr.

SPECIMENS EXAMINED. [4], on stem of *Rubus* sp. or *Vaccinium myrtillus*, KRAM M-1152; KRAM M-1154; [5], on stems of *Rubus* sp. or *Vaccinium myrtillus*, KRAM M-1150; KRAM M-1207; [11], on stems of *Vaccinium myrtillus* or grass culms, KRAM M-1158, duplicate in MA-Fungi; KRAM M-1156; [13], on stems of *Vaccinium myrtillus*, KRAM M-1206; KRAM M-1208; [14], on stems of *Vaccinium myrtillus*, KRAM M-1153, duplicate in MA-Fungi; [18], on fallen twigs of *Picea abies* and *Abies alba*, beechnut husks and mosses, KRA MYXO-522; [19], on beech leaves, grass culms and leaves of *Veronica officinalis*, KRA MYXO-518; KRA MYXO-524; [22], on stems of *Vaccinium myrtillus*, grass culms and needles of *Picea abies*, KRA MYXO-534; KRA MYXO-535; KRA MYXO-537.

COMMENTARY. According to the literature, *D. niveum* forms sporangia larger than (0.8)1 mm in diameter (e.g. Neubert et al. 1995, Moreno et al. 2003b). Some of our collections are characterized by sporangia smaller than 1 mm, which is characteristic of *D. microcarpum* Meyl. (Meylan 1924, Neubert et al. 1995, Moreno et al. 2003b). According to Meylan (1924), the capillitium of *D. microcarpum* should have pale colour similar to that of *D. globosum*. We measured sporangia of all our collections (10-20 measurements per collection). In only one collection (KRAM M-1207) were all sporangia smaller than 1 mm (0.66–0.94 mm) and the capillitium was pale macroscopically (but rigid and brown in transmitted light). All other collections have sporangia both smaller than 1 mm and bigger than 1 mm (on average 0.61–2.04) and dark, rigid capillitium. We identified all our specimens as *D. niveum*, although the collection KRAM M-1207 might be placed in *D. microcarpum*. Collections of *D. niveum* from the herbarium KRA mentioned above were previously published under the name *D. alpinum* (Drozdowicz 1985).

***Didymium dubium** Rostaf.

SPECIMENS EXAMINED. [2], on stems of *Rubus* sp., KRAM M-1128; KRAM M-1205; [4], on stems of *Rubus* sp., KRAM M-1126; [5], on stems of *Rubus* sp., KRAM M-1127; [14], on plant stems, KRAM M-1135.

***Lamproderma aeneum** Mar. Mey. & Poulain

SPECIMENS EXAMINED. [5], on stems of *Rubus* sp., KRAM M-1211, duplicate in herb. Marianne Meyer; [21], on a fern petiole, KRA MYXO-527. [9], on stems of *Rubus* sp. KRAM M-1261, duplicate in herb. Marianne Meyer.

COMMENTARY. Our specimens are characterized by slightly larger spores (10–12 µm) than stated in the original description, however, the variation of spore size for all the collections examined by the authors of the species (Poulain et al. 2002a) is also larger than in the type specimen.

Lamproderma carestiae (Ces. & De Not.) Meyl.

= *Lamproderma atrosporum* Meyl.

SPECIMENS EXAMINED. [2], on stems of *Rubus* sp., KRAM M-1230; [3], on stems of *Rubus* sp., KRAM M-1269; [4], on stems of *Rubus* sp., KRAM M-1218; KRAM M-

1248; together with *L. ovoideum* – KRAM M-1216 and KRAM M-1247; [**5**], on stems of *Rubus* sp., KRAM M-1226; KRAM M-1227; KRAM M-1228; [**8**], on stems of *Rubus* sp., KRAM M-1242, duplicate in MA-Fungi; [**9**], on stems of *Vaccinium myrtillus* or plant remnants, KRAM M-1237; KRAM M-1238; [**10**], on stems of *Rubus* sp. or *Vaccinium myrtillus*, KRAM M-1234; KRAM M-1235; [**11**], on stems of *Rubus* sp., KRAM M-1241; [**12**], on stems of *Vaccinium myrtillus*, KRAM M-1232; [**14**], on stems of *Rubus* sp. and *Vaccinium myrtillus*, KRAM M-1267 (together with *L. ovoideum*); [**22**], on stems of *Vaccinium myrtillus*, KRA MYXO-538.

COMMENTARY. The sporangia in all of our specimens are stipitate or, rarely, substipitate. Three forms are present in our material, differing from each other by the size of spores and pattern of ornamentation. One group is characterized by large spores, (12)13–17(19) µm, covered with isolated, regularly arranged spines about 1 µm long, the second form has smaller spores, 10–12(13) µm in diameter, covered with 0.5–1 µm long spines arranged in a (sub)reticulate pattern and the third form has smaller spores (10.5–12 µm) covered with irregularly arranged long spines (about 1 µm long), which tend to merge. One specimen (KRAM M-1237) has ornamentation, consisting of spines tending to fuse in groups. The great variability in spore size and ornamentation in *L. carestiae* is known and many different patterns (warts isolated, regularly arranged, irregularly arranged, forming subreticulate pattern) can be found (e.g. Neubert et al. 2000) in small-spored as well as large-spored and sessile as well as stipitate collections. In such a wide range of variability there are two possible interpretations: either distinguishing many species (or lower taxa) with a very narrow variation, or recognition of only one very variable taxon. Because in our opinion myxomycetes, especially nivicolous taxa, are very variable due to unstable environmental conditions in their habitats, we prefer to treat species in a wide sense and therefore we consider the variability in *L. carestiae* as rather continuous and prefer to treat it as one very variable species. Poulain et al. (2002b), who proposed the new generic name *Meriderma* for the outstanding complex species of *L. carestiae* (as "complexe «*atrosporum*»") recognize several taxa on a species level. Apart from *L. carestiae*, we consider *L. cribrarioides* a distinct taxon at species rank due to its distinct genetic position (Martin et al. 2003).

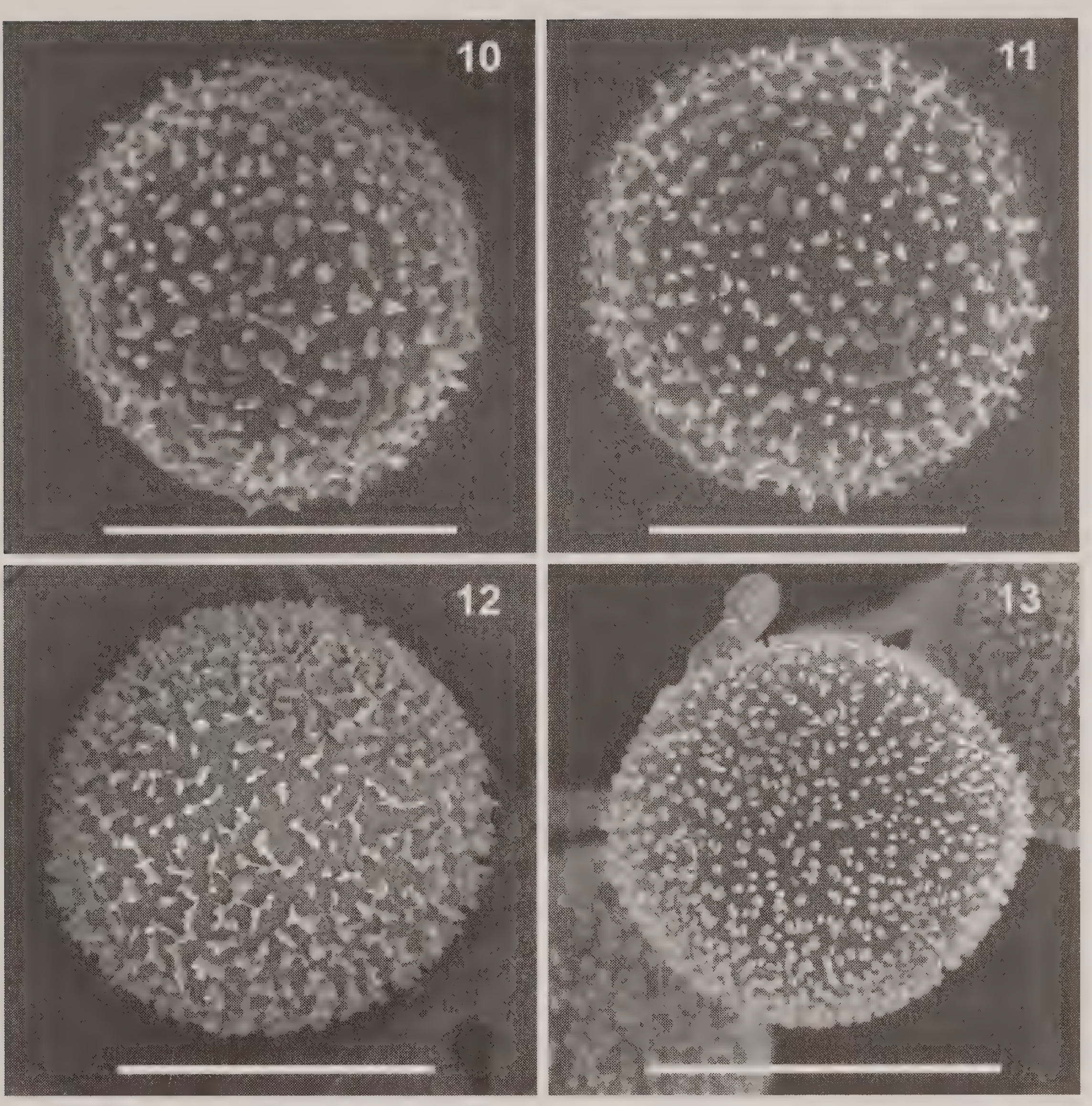
**Lamproderma cribrarioides* (Fr.) R.E. Fr.

= *Lamproderma atrosporum* var. *pseudocribrarioides* Mar. Mey. et al.

SPECIMENS EXAMINED. [**9**], on stems of *Vaccinium myrtillus*, KRAM M-1214.

**Lamproderma ovoideoechinulatum* Mar. Mey. & Poulain FIG. 10–12

SPECIMENS EXAMINED. [**4**], on stems of *Rubus* sp., KRAM M-1217; KRAM M-1288; [**5**], on stems of *Rubus* sp., KRAM M-1254; KRAM M-1222, duplicate in herb. Marianne Meyer; [**7**] on stems of *Rubus* sp., KRAM M-1287, duplicate in herb. Marianne Meyer; [**9**], on plant remnants, KRAM M-1236, duplicate in MA-Fungi and herb. Marianne



Figs. 10-12. spores of *Lamproderma ovoideoechinulatum*. 10. coll. KRAM M-1287. 11. coll. KRAM M-1233. 12. coll. KRAM M-1243. 13. a single spore of *Lamproderma ovoideum*, coll. KRAM M-1219. Bars = 10 µm.

> Meyer; [**10**], on grass and *Carex*, on stems of *Vaccinium myrtillus* and other plant remnants, on a stem and needles of a young spruce, KRAM M-1262, duplicate in herb. Marianne Meyer; KRAM M-1263, duplicate in herb. Marianne Meyer; KRAM M-1264, duplicate in herb. Marianne Meyer; KRAM M-1233, duplicate in MA-Fungi and herb. Marianne Meyer; [**14**], on stems of *Vaccinium myrtillus*, KRAM M-1243, duplicate in MA-Fungi and herb. Marianne Meyer.

Commentary. We identified this species on the basis of its spore ornamentation, which is in form of spines more than 0.5 µm long, longer and more clearly visible in light microscope than are those of *L. ovoideum*. Under SEM the spore ornamentation of *L. ovoideoechinulatum* was slightly different from that of *L. ovoideum*. The lectotype of *L. ovoideum* has spores covered with regularly arranged, isolated spines (Moreno et al. 2002). This feature was also observed in our collections of *L. ovoideum* (Fig. 13), while the spores of our collections of *L. ovoideoechinulatum* are covered with irregularly arranged spines tending to fuse into ridges or even a subreticulate pattern (Fig. 10-12). According to the original description (Poulain & Meyer 2005), *L. ovoideoechinulatum* is also characterized by a pyriform shape of the sporangia, but this feature was not well visible in our collections.

Lamproderma ovoideum Meyl. FIG. 13

SPECIMENS EXAMINED. [**1**], on stems of *Rubus* sp., KRAM M-1249; KRAM M-1250; [**3**], on stems of *Rubus* sp. and other plant remnants, KRAM M-1219, duplicate in herb. Marianne Meyer; KRAM M-1229, duplicate in herb. Marianne Meyer; KRAM M-1251; KRAM M-1252; [**4**], on stems of *Rubus* sp., KRAM M-1216, duplicate in MA-Fungi; KRAM M-1245; KRAM M-1246; KRAM M-1247; [**5**], on stems of *Rubus* sp. or on plant remnants, KRAM M-1221; KRAM M-1253; [**6**], on plant remnants, KRAM M-1255; KRAM M-1256; [**9**], on plant remnants, KRAM M-1257, duplicate in MA-Fungi; KRAM M-1258; [**10**], on stems of *Rubus* sp., KRAM M-1265, duplicate in herb. Marianne Meyer; [**12**], on stems of *Rubus* sp. or plant remnants, KRAM M-1212, duplicate in herb. Marianne Meyer; KRAM M-1231, duplicate in herb. Marianne Meyer; [**14**], on stems of *Rubus* sp. or *Vaccinium myrtillus*, KRAM M-1267; KRAM M-1268; [**20**], on plant remnants, KRAM M-1244, duplicate in herb. Marianne Meyer; [**21**], on a fern petiole, KRA MYXO-536; [**22**], on fern petioles or stems of *Vaccinium myrtillus*, KRA MYXO-528; KRA MYXO-529; KRA MYXO-530; KRA MYXO-532.

COMMENTARY. We distinguished *L. ovoideum* from *L. ovoideoechinulatum* on account of spore ornamentation, which is in the form of usually low, isolated spines in *L. ovoideum* (Fig. 13) (see remarks under *L. ovoideoechinulatum* above).

****Lamproderma pulveratum*** Mar. Mey. & Poulain

SPECIMENS EXAMINED. [**5**], on stems of *Rubus* sp., grass leaves and other plant remnants, KRAM M-1224, duplicate in herb. Marianne Meyer; KRAM M-1223, duplicate in MA-Fungi and herb. Marianne Meyer; KRAM M-1225, duplicate in herb. Marianne Meyer; [**9**], on stems of *Rubus* sp. or *Vaccinium myrtillus*, KRAM M-1260, duplicate in herb. Marianne Meyer; [**11**], on stems of *Rubus* sp. or *Vaccinium myrtillus*, KRAM M-1239, duplicate in herb. Marianne Meyer; KRAM M-1240, duplicate in herb. Marianne Meyer; KRAM M-1266.

COMMENTARY. Some of our collections possess all characteristic features of *L. pulveratum* (presence of lime crystals in peridium, "rough" peridium surface, dark, well visible warts covering spores), while in other collections, some of those features are lacking. The collections lacking crystals in peridium and possessing more delicately warted spores were identified by us as *L.* cf. *pulveratum*, as they seem to have an unclear position in the group of small-spored nivicolous species of *Lamproderma*.

Lamproderma sauteri Rostaf.

Specimens examined. [**11**], on remnants of *Centaurea* sp., KRAM M-1213, duplicate in MA-Fungi; [**22**], on grass culms, KRA MYXO-531.

****Lamproderma spinulosporum*** Mar. Mey. et al.

Specimens examined. [**22**], on grass culms, KRA MYXO-533.

Lepidoderma aggregatum Kowalski

Specimens examined. [**13**], on stems of *Vaccinium myrtillus*, KRAM M-1148; [**17**], on stems of *Vaccinium myrtillus* and *Veronica officinalis*, on grass culms, KRA MYXO-502; KRA MYXO-514.

Commentary. Based on the study of the type collection of *Lepidoderma aggregatum*, Moreno et al. (2004) concluded that this species hardly differs from *L. chailletii* and they synonymized both species. We could find in our material two distinct morphotypes. The majority of collections were characterized by a single peridium covered with whitish-greyish or whitish-ochraceous lime scales, giving the rough appearance of the surface. These specimens represent in our opinion *L. chailletii* (see below). The second morphotype was characterized by a double peridium. The outer layer, very distinctly separated from the inner one, was densely covered by very small crystals forming a continuous, shining crust. These specimens represent in our opinion *L. aggregatum*.

****Lepidoderma chailletii*** Rostaf.

Specimens examined. [**2**], on stems and leaves of *Rubus* sp., leaves of *Fagus sylvatica* KRAM M-1147, duplicate in MA-Fungi; KRAM M-1199; [**4**], on stems of *Rubus* sp., KRAM M-1142, KRAM M-1143; [**5**], on stems of *Rubus* sp. or *Hypericum maculatum*, culms of grasses, beech leaves, other plant remnants, KRAM M-1144; KRAM M-1145, duplicate in MA-Fungi and herb. Marianne Meyer; KRAM M-1146; [**6**], on a twig, on stems of *Vaccinium myrtillus* and grass culms, KRAM M-1141; KRAM M-1204; [**7**], on stems of *Rubus* sp., KRAM M-1197; [**8**], on stems of *Rubus* sp., KRAM M-1196; [**9**], on stems of *Vaccinium myrtillus*, KRAM M-1198; KRAM M-1201; [**10**], on stems of *Vaccinium myrtillus*, KRAM M-1202; [**14**], on stems of *Vaccinium myrtillus* and other plants, KRAM M-1195; KRAM M-1200; [**17**], on stems of *Vaccinium myrtillus* and *Veronica officinalis*, on grass culms and beech leaves, KRA MYXO-503; KRA MYXO-504; KRA MYXO-505; KRA MYXO-506; KRA MYXO-507; KRA MYXO-508; [**19**], on a stone, on grass culms, stems and leaves of *Veronica officinalis*, KRA MYXO-513; on grass culms, KRA MYXO-512; KRA MYXO-511; on grass culms, leaves of beech, stems and leaves of *Veronica officinalis*, KRA MYXO-510; KRA MYXO-509; KRA MYXO-539.

Commentary. Some collections from the locality [**19**] were previously published under the name *L. carestianum* (Rabenh.) Rostaf. (Drozdowicz 1985).

Physarum albescens Ellis ex T. Macbr.

Specimens examined. [**9**], on stems of *Vaccinium myrtillus*, KRAM M-1131, duplicate in herb. Marianne Meyer; [**13**], on stems of *Vaccinium myrtillus*, KRAM M-1132; [**14**], on stems of *Vaccinium myrtillus*, KRAM M-1136, duplicate in MA-Fungi; KRAM M-1140.

****Physarum alpestre*** Mitchel et al.

Specimens examined. [2], stems and leaves of *Rubus* sp., beech leaves, KRAM M-1130, duplicate in MA-Fungi; [4], stems of *Rubus* sp., KRAM M-1134; [5], on plant remnants, KRAM M-1129; [10], on grass culms, KRAM M-1133; KRAM M-1138; [14], on plant stems, KRAM M-1137; [16], on grass culms and remnants of *Carlina acaulis*, KRA MYXO-516; [17], on grass culms, KRA MYXO-515.

****Physarum vernum*** Sommerf.

Specimens examined. [18], on leaves of beech and stems of *Vaccinium myrtillus*, KRA MYXO-500.

Trichia alpina (R.E. Fr.) Meyl.

Specimens examined. [2], on fallen twigs, stems of *Rubus* sp., a leaf of beech, KRAM M-1125, duplicate in MA-Fungi and herb. Marianne Meyer; KRAM M-1139; [8] on stem of *Rubus* sp., KRAM M-1194; [13], on stems of *Vaccinium myrtillus*, KRAM M-1155; [15] on fallen twig of *Acer pseudoplatanus*, KRAM M-1193.

Commentary. One collection of *Trichia alpina* (site [15]) is particularly noteworthy from a phenological point of view, as it was made not in spring but in October, before the first snow fall, on a twig of *Acer pseudoplatanus*. The collection is typical, well developed and seems to be fresh, as the short plasmodiocarps are still closed, therefore they were probably formed just before collection, and not persisting from the spring period. Interestingly, also Meylan (1929, 1932) mentions an autumnal collection of this species from the Swiss Jura Mts., also occurring on twigs of *Acer* and *Sorbus*. He did not notice any morphological differences, but remarked that these phenologically distinct collections could represent biologically distinct forms.

Discussion

A considerable diversity of nivicolous myxomycetes was found in the Gorce Mountains, and almost all collected species were strictly nivicolous. The presence of these organisms was repeatedly connected with a mass occurrence of some species, such as *Diderma niveum*, *Lepidoderma chailletii* or *Lamproderma ovoideum*, which played an important role in the springtime aspect of glades and shrub communities. Thanks to the long-term observations carried out during spring time of six years we could not only obtain a general picture of the diversity of nivicolous myxomycetes of the lower parts of the Carpathians, but also find more rare species noticed during regular, repeated observations. Our results show that nivicolous slime moulds can be found not only in alpine and subalpine zones of high mountains but they can also occur abundantly in low-mountain massifs. The lowest elevation in the present collections was 880 m a.s.l., but snowbank myxomycetes were collected in the Polish

Carpathians even lower. So far, the lowest collection of *Diderma globosum* var. *europaeum* was found at 583 m a.s.l. (K. Nowak, unpublished data). According to our observations, *Diderma alpinum, D. niveum, Lamproderma sauteri, Lepidoderma chailletii, Physarum alpestre* and *P. vernum*, which were mentioned as dominating in the highest elevations of Scottish or Spanish mountains (Ing 1998, Lado 2004), are also present not only in the lowest locations of montane meadows, but also of montane forest in the Gorce mts., and some of them are very common here (*Lepidoderma chailletii* and *D. niveum* were among the most frequently encountered and the most abundantly occurring species).

Most collections from the Gorce Mountains were found by us in open areas such as mountain meadows, but it is noteworthy that we also found several specimens in a loose but regular canopy beech or spruce forest, where no open areas such as glades or meadows were present. It should be noted, however, that during the period of snow melting in spring broadleaved trees are still devoid of leaves, therefore, even in a regular canopy beech forest there is an abundance of light in the forest bottom. The occurrence of nivicolous species at patches of melting snow remaining between trees was also observed by Lado (2004) in the Spanish mountains.

Nivicolous myxomycetes are usually found in close vicinity (up to a few meters) of melting snowbanks (e.g. Stephenson & Johnston 2003), and this was also true in the case of our study. But, interestingly, several of our collections were found also in places devoid of snow cover for a long time. Such places were usually located at the lowest elevations, in regions where even small snow patches were already absent. Very delicate sporangia of slime moulds are usually very easily damaged by wind or rain; therefore, they are most likely to be found just after formation. During rainy springs it is difficult to find any specimens even close to the snowbanks, because they are damaged during transformation from plasmodium to sporangia. Collections made during a dry and sunny spring of 2006 demonstrated that in long periods of favourable weather conditions the sporangia of nivicolous species can persist for a considerable length of time after snow melting.

There are still too few data sets for general conclusions about distribution and ecological preferences of nivicolous species in Europe. Our study shows that the Carpathians, like the Alps and Iberian mountains, harbour diverse communities of nivicolous myxomycetes, confirming the wide distribution of these organisms. A comparison of the low-mountain and high-mountain areas of the Carpathians is being planned to estimate how the ecological conditions at various climatic belts influence the diversity of snowbank slime moulds.

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Literature cited

Bozonnet J, Meyer M, Poulain M. 1991. Espèces nivales de myxomycètes. Bull. Soc. Hist. Nat. Pays Montbéliard: 51–72.

Cochet S, Bozonnet J. 1984. Les Myxomycètes de France. Nouveautés et compléments (II). Bull. Trimestriel Soc. Mycol. France 100(3): 39–64.

Drozdowicz A. 1985. *Diderma alpinum* Meylan and *Lepidoderma carestianum* (Rab.) Rost. – species of myxomycetes new to the flora of Poland. Zesz. Nauk. Uniw. Jagiellon. Prace Bot. 13: 115–119.

Drozdowicz A. 1988. Species of myxomycetes connected with thawing – new in Poland. Folia Societatis Scientiarum Lublinensis 30 (Biologia 1–2): 31–33.

Drozdowicz A. 1995. Myxomycetes of melting snow banks in Polish mountains. Abstracts of the XII Congress of European Mycologists. Wageningen: 18–19.

Drozdowicz A. 1997. Preliminary studies on *Myxomycetes* in the Bieszczady National Park. Roczniki Bieszczadzkie 5: 253–256.

Drozdowicz A. 2000. Materials to the chorology of *Myxomycetes* in the Bieszczady Mts. Roczniki Bieszczadzkie 9: 53–60.

Hernández-Crespo JC, Lado C. 2005. An on-line nomenclatural information system of Eumycetozoa. (http://www.eumycetozoa.com)

Ing B. 1998. Alpine myxomycetes in Scotland. Botanical Journal of Scotland 50:47–53.

Komorowska H, Drozdowicz A. 1996. Śluzowce In: Mirek Z, Głowaciński Z, Klimek K, Piękoś-Mirkowa H. eds. Przyroda Tatrzańskiego Parku Narodowego. Zakopane–Kraków: Tatrzański Park Narodowy: 405–412.

Kornaś J. 1955. Charactéristique géobotanique des Gorces (Karpathes Occidentales Polonaises). Monogr. Bot. 3: 1–216.

Krivomaz T, Meyer M, Michaud A. 2005. First search for nivicolous myxomycetes in the Ukrainian Carpathians and collection of samples for isolation of dictyostelids and protostelids. International Congress on Systematics and Ecology of Myxomycetes ICSEM 5. Tlaxcala, Mexico. Abstracts of oral and poster presentations: 50.

Lado C. 2004. Nivicolous myxomycetes of the Iberian Peninsula: considerations on species richness and ecological requirements. Syst. Geogr. Pl. 74: 143–157.

Lado C, Ronikier A, Ronikier M, Drozdowicz A. 2005. Nivicolous myxomycetes from Sierra de Gredos (Central Spain). Nova Hedwigia 81(3–4): 371–394.

Martin MP, Lado C, Johansen S. 2003. Primers are designed for amplification and direct sequencing of ITS region of rDNA from *Myxomycetes.* Mycologia 95(3): 474–479.

Meyer M. 1986. Les espèces nivales de myxomycètes. 1ère partie. Bull. Trimestriel Féd. Mycol. Dauphiné-Savoie 100: 51–54.

Meyer M, Bozonnet J, Poulain M. 1996. Ecology and presentation of the nivicolous myxomycetes. Abstracts of the 2nd International Congress on the Systematics and Ecology of Myxomycetes, Madrid, Spain: 67.

Meylan Ch. 1924. Recherches sur les Myxomycètes du Jura en 1921–22–23. Bull. Soc. Vaud. Sci. Nat. 50(182): 1–14.

Meylan Ch. 1929. Recherches sur les Myxomycètes en 1927–28. Bull. Soc. Vaud. Sci. Nat. 57(223): 39–47.

Meylan Ch. 1931. Contribution à la connaissance des myxomycètes du Jura et des Alpes. Bull. Soc. Vaud. Sci. Nat. 57(227): 301–307.

Meylan Ch. 1932. Les espèces nivales du genre *Lamproderma.* Bull. Soc. Vaud. Sci. Nat. 57(228): 359–373.

Miczyński J. 2006. Klimat. In: Różański W. ed. Gorczański Park Narodowy. 25 lat ochrony dziedzictwa przyrodniczego i kulturowego Gorców. Poręba Wielka: Gorczański Park Narodowy: 35–37.

Moreno G, Sánchez A, Singer H, Illana C, Castillo A. 2002. A study on nivicolous *Myxomycetes.* The genus *Lamproderma* I. Alassio: Edizioni Candusso: Fungi non Delineati 19, 66 p.

Moreno G, Sánchez A, Castillo A, Singer H, Illana C. 2003a. Nivicolous myxomycetes from the Sierra Nevada National Park (Spain). Mycotaxon 87: 223–242.

Moreno G, Singer H, Illana C, Sánchez A. 2003b. SEM-studies on nivicolous *Myxomycetes.* The *Diderma niveum* complex in Europe. Cryptog. Mycol. 24(1): 39–58.

Moreno G, Singer H, Illana C. 2004. A taxonomic review on the nivicolous myxomycete species described by Kowalski. II. *Physarales* and *Trichiales.* Österr. Z. Pilzk. 13: 61–74.

Neubert H, Nowotny W, Baumann K. 1993. Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Berücksichtigung Österreichs. Band 1. Gomaringen: Karlheinz Baumann Verlag, 343 p.

Neubert H, Nowotny W, Baumann K. 1995. Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Berücksichtigung Österreichs. Band 2. Gomaringen: Karlheinz Baumann Verlag, 368 p.

Neubert H, Nowotny W, Baumann K. 2000. Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Berücksichtigung Österreichs. Band 3. Gomaringen: Karlheinz Baumann Verlag, 391 p.

Ozenda P. 1985. La Végétation de la Chaîne Alpine dans l'Espace Montagnard Européen. Paris: Masson, 330 p.

Poulain M, Meyer M, Bozonnet J. 2002a. *Lamproderma carestiae* (Ces. & de Not.) Meyl. et *Lamproderma aeneum* sp. nov. Bull. Soc. Hist. Nat. Pays Montbéliard: 47–54.

Poulain M, Meyer M, Bozonnet J. 2002b. *Lamproderma* nivicoles du groupe *atrosporum* Meylan. Scripta Botanica Belgica 22: 75.

Poulain M, Meyer M. 2005. Les *Lamproderma* (*Myxomycota, Stemonitales*) du groupe *ovoideum.* Bull. Trimestriel Féd. Mycol. Dauphiné-Savoie 176:13–30.

Ronikier A, Ronikier M. 2007. New records of nivicolous myxomycetes from the South-Eastern European mountains. Mycol. Balcanica 4(3): 143–146.

Sánchez A, Moreno G, Illana C, Singer H. 2002. A study of nivicolous myxomycetes in Southern Europe, Sierra de Guadarrama, Spain. Persoonia 18(1): 71–84.

Schinner F. 1982. Myxomycetes des Großglockner Gebietes (Hohe Tauern, Österreich) (Eine ökologische Studie). Z. Mykol. 48(1): 165–170.

Singer H, Moreno G, Illana C, Kirchmair M. 2001a. Nivicolous myxomycetes from Tyrol (Austria). I. Cryptog. Mycol. 22(2): 79–94.

Singer H, Moreno G, Illana C. 2001b. Nivicolous myxomycetes from Tyrol (Austria). II. The genus *Lamproderma*. Österr. Z. Pilzk. 10: 25–42.

Stephenson SL, Johnston PR. 2003. Myxomycetes and fungi associated with alpine snowbank habitats in New Zealand. Australas. Mycol. 22(1): 20–26.

Wichanský E. 1962. Několik druhů, odrůd a forem vzácnějších nebo méně známých hlenek (Myxomycetes) z nálezů v letech 1957 až 1960 v ČSSR. Česká Mykol. 16(1): 34–43.

Wichanský E. 1963. Československé druhy rodu *Trichia* – závitěnka (*Myxomycetes*) Česká Mykol. 17(2): 91–97.

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A new species of *Pleurocollybia* (*Tricholomataceae; Agaricales; Basidiomycetes*) from Belize

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Abstract—A new species, *Pleurocollybia imbricata*, is described from the Maya Mountains of Belize and a new combination in *Pleurocollybia* is proposed. A key to the known species of *Pleurocollybia* is also provided.

Keywords—agarics, Doyle's Delight, siderophilous inclusions, taxonomy

Introduction

Pleurocollybia Singer was proposed as a new monotypic genus to accommodate *Gymnopus praemultifolius* Murrill (Murrill 1945) based on several features: eccentric stipe, clampless hyphae, minute basidiospores (very small for an agaric, e.g. "2.7-3.5 × 2.5-3.2 µm"), and lack of necropigments (Singer 1947). Singer (1947) compared *Pleurocollybia* to two morphologically similar genera, *Callistosporium* Singer and *Podabrella* Singer (now considered a synonym of *Termitomyces*, Frøslev et al. 2003), but separated *Pleurocollybia* from them by the eccentric stipe and very small basidiospores. *Podabrella* (= *Termitomyces*) produces a reddish/pinkish colored spore deposit while those of *Pleurocollybia* and *Callistosporium* are white. *Podabrella* (= *Termitomyces*) also produces siderophilous bodies in the basidia, while siderophilous bodies are not present in *Pleurocollybia*. *Callistosporium* has abundant brightly colored necropigments in the basidiospores, basidia and tramal hyphae, while these pigments are not present in *Pleurocollybia*. A BLAST search based on ITS sequences from *Pleurocollybia imbricata* match closely to several ITS sequences of exemplars of *Callistosporium*. Although not definitive, this similarity in ITS sequences may indicate a close relationship with *Callistosporium* as Singer originally suspected (Singer 1947) and seems to be indicated by a study of the nlsu rDNA region as well since *Callistosporium* and *Pleurocollybia* are found in the same clade, the /callistosporioid clade (Moncalvo et al. 2002).

Since 1947, eight more species have been added to *Pleurocollybia*, including four new species described from the neotropics by Singer (Singer 1955, 1963, 1969, 1978), and 2 new combinations into *Pleurocollybia* from existing neotropical taxa (Singer 1970, 1986). Two additional species were placed in the genus by recombinations of existing taxa, one from Sri Lanka/Africa (Pegler 1977) and one from New Zealand (Horak 1971). With the addition of this newest taxon, and the new combination proposed in this paper, we now know of 11 species that belong in the genus, with the greatest number being New World neotropical taxa (9 species).

Pleurocollybia is characterized by a combination of distinctive features: the stipe is typically eccentric or lateral or lacking, only a truly central stipe is known for two species, thus the habit is pleurotoid or collybioid-pleurotoid, the lamellae are crowded and very narrow, adnate or adnexed or emarginate-adnexed, the lamellulae are truncate, the basidiospores are small and white in deposits, smooth, inamyloid, the basidia lack siderophilous/cyanophilous bodies, the basidiospores, basidia and hyphae of the trama lack of necropigments, and the habitat for the basidiomata is typically lignicolous on rotting wood. Clamps may be present or absent.

A key to all known species is provided.

Materials and methods

Color notations in the macroscopic descriptions are from Kornerup & Wanscher (1978). Methods used in preparation of microscopic structures were those of Baroni (1981). Testing for cyanophilic reactions of spore walls and for cyanophilic bodies in basidia was carried out as follows: un-revived dry lamella fragments were gently heated over a flame in a drop of cotton blue/lactic acid (Singer 1986) on a clean glass slide; when the mountant began to release vapor (not boiled), the fragment was removed and placed in a clear drop of lactic acid at room temperature and washed to remove excess dye. This fragment was finally transferred to a fresh drop of clear lactic acid at room temperature on a clean slide to make a squash mount. It has previously been shown that siderophilous inclusions in basidia can be determined by using the cotton blue/lactic acid test described above (Baroni 1981), since siderophilous inclusions stain in a similar fashion in cotton blue. All measurements of anatomical features were made in mounts of 3% KOH under an oil immersion lens. The designations used for basidiospore measurements are those of Baroni & Horak (1994) where n = number of spores measured, Q = range of length/width of individual spores and Q_m = mean of those Q values. All measurements were made with an Olympus BHS light microscope under Hoffman interference optics using an ocular micrometer or by using a semi-automated image analysis system (a GTCO digitizer pad and Metrics5 software written by Dr. David Malloch). Descriptive statistical analysis of the measurements was obtained using EXCEL 5.0 and SigmaStat 1.0. All illustrations of microscopic features were made with the aid of a drawing tube and the final plates were prepared using a WACOM pen drawing tablet and Adobe Illustrator 10. All longitude/latitude readings listed were made by hand held GPS (GARMIN Etrex Vista) set on the WGS84 Datum standard or the UTM standard.

Taxonomy

New species

Pleurocollybia imbricata T.J. Baroni, Lodge & D. L. Lindner, **sp. nov.**

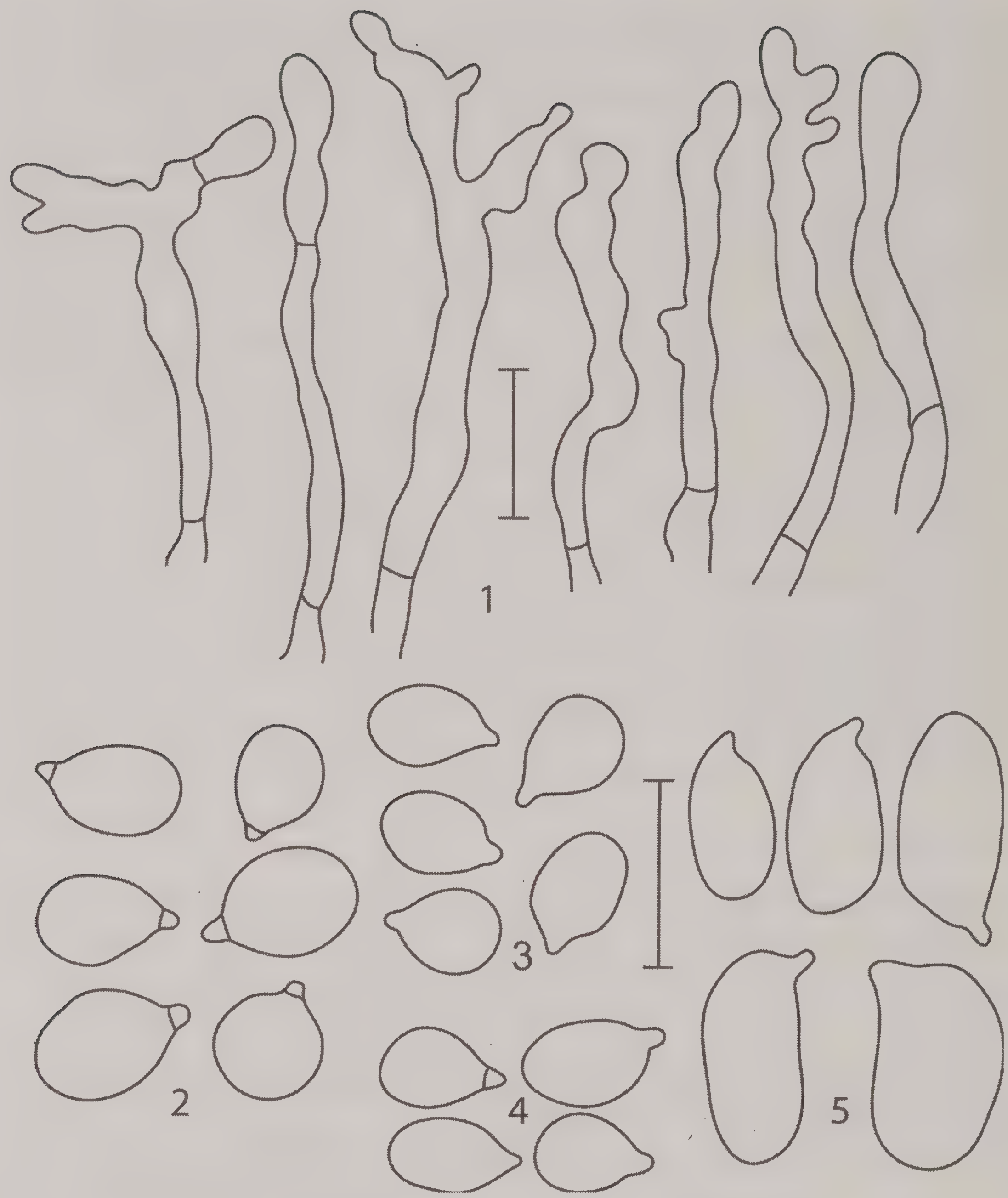
Mycobank MB510698 FIGS. 1-2, 6

Basidiomata pleurotoidea, imbricata, in subiculo crasso albo implicito, in ligno putrido. Ab congeneribus differt basidiomatibus dense imbricato-compaginatis ut videtur stipite carentibus, marginibus pilei profunde incisis lobatisque, pileo incano pallide canido-brunneo, odore farinaceo, sapore amaro farinaceo, basidiosporis parvis subglobosis, 3-4 × 2-3.2 um, cheilocystidiis cylindricis contortis.

HOLOTYPE T. J. Baroni 9847, Maya Mountains, Belize (BRH; ISOTYPES, CORT, NY)

ETYMOLOGY — From the Latin *imbricatus*. The species is named for its overlapping pilei, like roof tiles.

BASIDIOMATA pleurotoid, densely imbricate and produced from a thick white matted subiculum on decaying woody substrate. PILEUS pale grayish buff or grayish orange or grayish brown (5–6B2–3, Alabaster, Birch Bark, Flesh or 5C2–3, Birch Grey, Brownish Orange), 15–60 mm broad, plano-convex becoming plane (or when young and on top of the woody substrate infundibuliform! – only one basidioma out of 30 or more), irregularly dimidiate, subspathulate, deeply incised, lobed, lobes overlapping, producing small conchate "caps" from margins of lobes, densely imbricate-shelving, hoary canescent over most of surface with darker brown colors below canescence, canescence often grown over or around small bits of woody debris trapping particles on the surface, margin inrolled.



Figs. 1-2: *Pleurocollybia imbricata* (9847 TJ Baroni, Isotype):
Fig. 1, cheilocystidia, scale bar = 10 μm. Fig. 2, basidiospores.
Fig. 3 *Pleurocollybia densifolia* (F.S. Earle 578, Holotype) — basidiospores.
Fig. 4 *Pleurocollybia praemultifolia* (F17468, Holotype) — basidiospores.
Fig. 5. *Pleurocollybia amara* (F17336, Holotype) — basidiospores.
Scale bar for all basidiospores = 5 μm.

Context watery grayish brown, approx. 1 mm thick. LAMELLAE grayish brown (± concolorous with pileus) but also with flesh pinkish hues, adnexed or adnate, extremely crowded with numerous irregular tiers of truncate lamellulae, some so tightly crowded they have grown together, frequently producing ball-like clumps of white pubescent outgrowths on the fused lamella edges, moderately

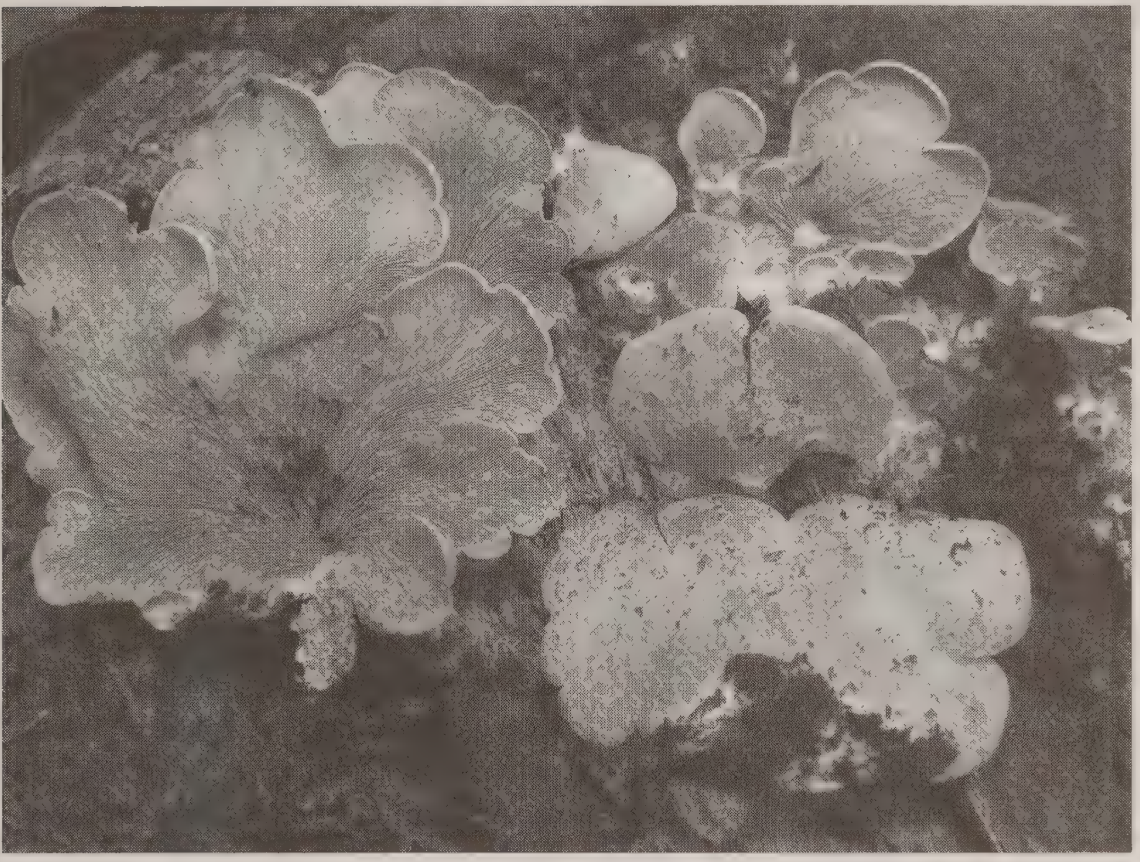


Fig. 6. *Pleurocollybia imbricata* basidiomata in situ. TYPE (9847 T. J. Baroni). 1×.

broad (± 1 mm), edges ± even, concolorous with faces. STIPE central at first but quickly strongly eccentric or lateral and highly reduced, approx. 1 mm × 1 mm, densely white fibrillose appressed; all stipes arising from a dense, thick whitish subiculum covering the woody substrate. ODOR fruity at first or when cut, farinaceous when flesh is crushed. TASTE bitter!! and farinaceous.

BASIDIOSPORES 3–4 × 2–3.2 um, (n=41, L_m= 3.3 ± 0.19, W_m= 2.6 ± 0.32, Q= 1.07–1.3 (–1.6), Q_m = 1.26 ± 0.14), subglobose or broadly ellipsoid, round in polar view, smooth, with a very small apiculus (< 0.5 μm), hyaline, inamyloid, weakly cyanophilic or acyanophilic. BASIDIA 8–12.1 × 4–5.6 μm, 4-sterigmate, broadly clavate, hyaline, lacking cyanophilic bodies. CHEILOCYSTIDIA hyaline, scattered or abundant, cylindrical, frequently contorted, often branched, some subclavate, some septate, (14–) 22–36 × 2.4–3.2 μm. PLEUROCYSTIDIA absent. LAMELLAR TRAMA composed of parallel hyphae, cylindric or slightly inflated, 4–16 um in diam, cells mostly short. PILEUS CONTEXT hyaline, a compact layer of short cylindrical hyphae, 4.8–16.2 um in diam. PILEIPELLIS hyaline, 60–120 um deep, of loosely entangled, erect, cylindrical hyphae, 1.6–4.8 um in diam., mostly trichodermial in aspect, hyphal ends frequently contorted, and often branched. CLAMP CONNECTIONS absent.

Habit: Lignicolous on downed decaying large (40-60 cm diam) dicotyledenous log, over mosses on the side and underside of the log. August.

Material examined: Belize; Cayo District, Maya Mountains, Doyle's Delight UTM 81843W 24593W, 1035 m alt., on north trail to creek from summit, in creek bed area, 13 August 2004, T. J. Baroni 9847 (with Dan Lindner), (HOLOTYPE: BRH; ISOTYPES: NY, CORT).

Additional material examined: *Gymnopus praemultifolius*, USA, Florida, Alachua County, Gainesville area, on decaying hardwood log, shade, 7 July 1938, collected and determined W. A. Murrill, F17468 (HOLOTYPE: FLAS). *Gymnopus densifolius* Murrill, Jamaica, Port Antonio, on a much decayed stump, 23 November 1902, F. S. Earle 578 (HOLOTYPE: NY)

Comments: *Pleurocollybia imbricata* is distinguished from other species in this genus by the lateral obscure stipes arising from a thick whitish subiculum, the deeply incised and frequently lobed margins on the imbricate pilei, the hoary-canescent grayish pileus surface and the conspicuous cheilocystidia (Figs. 1 & 6). Macroscopically, this taxon may be confused with *P. apoda*, *P. paradoxa*, or *P. praemultifolia*. *P. imbricata* is similar to *P. apoda* and *P. paradoxa* due to the absence or obscurity of stipes at maturity. *P. imbricata* is different from both of these taxa, because it produces at maturity imbricate shelving basidiomata. *P. apoda* and *P. paradoxa* do not produce imbricate shelving basidiomata. In addition, *P. imbricata* has cheilocystidia. *P. apoda* and *P. paradoxa* lack cheilocystidia. *P. imbricata* has a hoary-canescent pileaus surface, while *P. apoda* and *P. paradoxa* have glabrous pileus surfaces.

Pleurocollybia imbricata is similar to *P. praemultifolia*, in that, they both have imbricate basidiomata and they produce conspicuous cheilocystidia. However, *P. imbricata* has a pale grayish or grayish brown colored hoary-canescent pileus and the individual basidiomata are produced from a dense whitish subiculum on highly reduced, lateral obscure stipes, while *P. praemultifolia* has a chestnut colored glabrous pileus and the conspicuous stipes are merely eccentric and not arising from a subiculum. The basidiospores of *P. imbricata* are subglobose or broadly ellipsoid (Fig. 2) and are larger than the spores of *P. praemultifolia* (Fig. 4).

New Combinations

Pleurocollybia amara (Murrill) Singer ex T. J. Baroni & Bocsusis, **comb. nov.**
MycoBank MB510957 Fig. 5
Basionym: *Gymnopus amarus* Murrill, Proc. Fla. Acad. Sci. 7:109. 1945
≡ *Collybia amara* Murrill, Proc. Fla. Acad. Sci. 7:127. 1945, nom. alt.

Singer (1975, 1986) listed *Pleurocollybia amara* as one of the seven, and then eight, species he accepted in the genus. However, after searching the literature (Mueller & Wu 1997; http://www.speciesfungorum.org/Names/Names.asp), it became obvious to us that Singer never validly published the new combination he had originally discussed (Singer 1970). We borrowed the type and the information we obtained is described below. *Gymnopus amarus* belongs in *Pleurocollybia* and we validate that new combination here.

The following description of macroscopic features is from Murrill (1945).

> "Pileus conic-convex, not expanding, cespitose, 2 cm broad; surface dry, smooth, glabrous, avellaneous, the disk tinged with isabelline, margin even, entire, inflexed; context thin, gray, opaque, bitter at once, odorless; lamellae adnate, inserted, narrow, close, white, unchanging, entire to eroded; spores ellipsoid, smooth, hyaline, uniguttulate, 5–6 × 3–4 μ; stipe tapering upward, smooth, glabrous, white, 3 × 0.3–0.6 cm. Type collected by West and Murrill on a much-decayed pine log in Sugarfoot Hammock, near Gainesville, Fla., August 4, 1938 (F17336). Gray above and white below, with bitter flesh."

Microscopic features were obtained from our examination of the holotype:

BASIDIOSPORES 5.6–7.2 × 3–4 μm (n = 10, L_m = 6.27 ± 0.57, W_m = 3.37 ± 0.35, Q = 1.75–2, Q_m 1.86 ± 0.10), ellipsoid in face and profile, round in polar view, smooth, hyaline, inamyloid, acyanophilous. BASIDIA 19.4–24.3 × 5.6–6.4 μm, 4-sterigmate, clavate, hyaline, lacking cyanophilous bodies. HYMENIAL CYSTIDIA absent. CLAMPS present on hyphae in hymenium.

HABITAT: Lignicolous on well decayed pine log. August.

Material examined: USA, Florida, Alachua County, Gainesville area, Sugarfoot Hammock. 4 August 1938, West and Murrill F17336 (HOLOTYPE: FLAS)

COMMENTS: The small, inamyloid, acyanophilous, smooth basidiospores, crowded, narrow lamellae, truncate lamellulae (?), lack of necropigments, lack of cyanophilous bodies in the basidia, bitter taste and habitat on decaying wood indicate this species belongs in *Pleurocollybia* even though the stipe is not conspicuously and consistently eccentric (Singer 1970). Singer (1986) clearly accepted this species in *Pleurocollybia* but never formally made the combination he considered some time earlier (Singer 1970). He did not make the combination earlier because this species was one of just a few taxa of *Pleurocollybia* that possessed clamp connections on its hyphae and did not show clearly eccentric stipe attachments. Since this taxon is not commonly collected (we only know of the type collection), it has not been the subject of a molecular phylogenetic analysis as yet.

Unfortunately the holotype of *G. amarus* consists of only broken fragments and these are not plentiful nor in very good condition. One can determine that the lamellae are crowded and narrow, but that is all. Most of the remaining lamellae and lamellulae on the pileus fragments have been shattered at the pileus connection so that few whole structures are left. It is not possible to determine if the lamellulae where truncate on the few pileus fragments remaining. However, Singer (1970) indicates that *Gymnopus amarus* has the typical truncate lamellulae.

Table 1 – Abbreviated bibliographic and distribution information for species of *Pleurocollybia*.

TAXON	PUBLISHED AS *PLEUROCOLLYBIA*	DISTRIBUTION
P. amara	(2008) This publication	Florida
P. apoda Singer	1955 Mycologia 47: 769	Panama
P. brunescens	1973 Beih. Sydowia 7: 17	Cuba
P. cibaria Singer	1963 Bol. Soc. Argent. 10: 207	Peru
P. cremea (G. Stev.) E. Horak	1971 N.Z. J. Bot. 9: 415	New Zealand
P. densifolia (Murrill) Singer	1986 Agar. In Mod. Tax., Ed.4, p. 280	Jamaica
P. imbricata	(2008) This publication	Florida
P. paradoxa Singer	1969 Beih. Nova Hedwigia 29: 55	Chile
P. praemultifolia (Murrill) Singer	1947. Mycologia 39(1): 80	Florida
P. pulcherrima Singer	1978 Nova Hedwigia 29: 12	Colombia
P. versiformis (Berk.) Pegler	1977 Kew Bull. Add. Ser. VI: 96	Sri Lanka (Type) & Tanzania

Clarifications

Pleurocollybia brunescens (Earle) Singer,
[as *brunnescens*] *Beih. Sydowia* 7: 17 (1973)
≡ *Geopetalum brunescens* Earle, 1906, In. An. Est. Cent. Agr. de Cuba 1:235, non
[≡ '*Micromphale brunnescens* Earle', sensu Dennis 1953, lapsus calami].

In the process of obtaining information on all known taxa of *Pleurocollybia*, we discovered misinformation in the published literature that had been followed by several authors and was cited in Index Fungorum incorrectly. [The information in Index Fungorum has since been corrected after we pointed out the problems.] The basionym for *Geopetalum brunescens* Earle was cited incorrectly in the literature as a *Micromphale brunnescens* (sic) Earle by Dennis (1953), Pegler (1977, 1983) and Singer (1973) apparently based on an error in citation by Dennis (1953). There is no *Micromphale brunnescens* described in the literature, by Earle or any other author. Pegler (1987) obviously recognized the error by correctly listing the synonyms of *Pleurocollybia brunnescens* (sic) as *Geopetalum brunnescens* (sic) but incorrectly maintaining the spelling of the specific epithet as *brunnescens* instead of the original and perfectly correct *brunescens.*

Key to the known species of *Pleurocollybia*

1. Stipe present and typically eccentric or lateral at maturity, rarely central 2

1. Stipe absent or obscure at maturity 9

2. Pileus ± 4 mm broad when dried; stipe 11 × 0.4 mm; pileus, stipe and basal mycelium violet colored; spores 3–4.5 × 2.5–3 µm (Singer 1978) .... *P. pulcherrima*

2. Pileus larger; stipe broader; violet colors absent 3

3. Fruit bodies white or cream color 4

3. Fruit bodies tan or cinnamon-brown or chestnut brown or grayish 5

4. Pileus 20-100 mm broad, white, spathulate, translucent, non-striate; spores 5.5–8 × 3.5–4.5 µm (Pegler 1977) .... *P. versiformis*

4. Pileus 15–35 mm broad, cream-white or deep cream color, orbicular or reniform; spores 2.5–3.5 × 2.5 µm, weakly amyloid (Segedin 1996!) .... *P. cremea*

5. Pileus 10–15 mm broad, cinnamon-brown; stipe pallid, 10 mm × 2 mm, eccentric with maturity, pruinose especially above; spores globose or subglobose, (4–5 µm Murrill 1916; 2.3–2.8 × 1.7–2.2 µm short ellipsoid, Singer 1970; 3.2–4 × 2.4–3.2 µm, ! from Holotype, Fig. 3) .... *P. densifolia*

5. Pileus larger than 15 mm 6

6. Pileus spathulate, pale grayish brown; stipe lateral, white, silky; spores globose 3-4 µm (Earle 1906) .... *P. brunescens*

6. Pileus orbicular; stipe eccentric or central 7

7. Gregarious on soil among moss; stipe central; taste mild .... *P. cibaria*

7. Lignicolous; taste bitter 8

8. Basidiomata densely imbricate; pileus livid chestnut, 35-45 mm broad, odor of anise, taste bitter; stipe eccentric, pruinose, pale yellowish-white; cheilocystidia present, cylindrical-contorted, narrowly clavate, some branched; spores 1.5–2.0 µm (Murrill 1945), but 2.8–3.2 × 2.4–2.8 µm (! from Holotype) .... *P. praemultifolia*

8. Basidiomata not imbricate; pileus avellaneous or disc isabelline, 20 mm broad, odorless, taste bitter; stipe central, glabrous, white; cheilocystidia absent; spores ellipsoid, 5-6 × 3–4 µm (Murrill 1945; 5.6–7.2 × 3–4 µm TYPE!) .... *P. amara*

9. Basidiomata imbricate shelving; pileus 15–60 mm broad, margins deeply incised and frequently lobed, pale-grayish buff or grayish-brown, surface hoary-canescent; cheilocystidia present; spores 3–4 × 2–3.2 µm, subglobose or ellipsoid .... *P. imbricata*

9. Basidiomata not imbricate; pileus margin not incised or lobed, surface glabrous; cheilocystidia absent 10

10. Pileus up to 42 mm broad, pale ochraceous; spores 2.7–3.0 × 1.8–2.0 µm, ellipsoid .... *P. apoda*

10. Pileus up to 11 mm broad, pale cinnamon brown; spores 3–5 × 2–2.5 µm, ellipsoid .... *P. paradoxa*

Acknowledgements

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Literature cited

Baroni TJ. 1981. A revision of the genus *Rhodocybe* Maire (*Agaricales*). Beih. Nova Hedwigia 67:1-194.

Baroni TJ, Horak E. 1994. *Entolomataceae* in North America III: new taxa, new combinations and notes on species of *Rhodocybe*. Mycologia 86: 138--145.

Dennis RWG. 1953. Some pleurotoid fungi from the West Indies. Kew Bull. 8:31-45.

Earle FS. 1906. Algunos hongos cubanos. Inf. An. Estac. Centr. Agron. Cuba 1:225-242.

Frøslev TG, Aanen DK, Læssøe T, Rosendahl S. 2003. Phylogenetic relationships of *Termitomyces* and related taxa. Mycol. Res. 107:1277-1286.

Horak E. 1971. A contribution towards the revision of the *Agaricales* (*Fungi*) from New Zealand. New Zealand Journal of Botany 9(3):403-462.

http://www.speciesfungorum.org/Names/Names.asp. Index Fungorum, CABI Bioscience Databases (2007)

Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. 3rd ed. E. Methuen, London, United Kingdom. 252 pp

Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime CA, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clémençon H, Miller OK Jr. 2002. One hundred and seventeen clades of euagarics. Molecular Phylogenetics and Evolution 23:357-400.

Mueller GM, Wu Q. 1997. Mycological contributions of Rolf Singer: field itinerary, index to new taxa, and list of publications. Fieldiana 38:1-124.

Murrill WA. 1916. (*Agaricales*) *Agaricaceae* (pars) *Agariceae* (pars). The North America flora. 9 (5): 297-374.

Murrill WA. 1945. New Florida fungi. Proc. Fla. Acad. Sci. 7:107-127.

Pegler DN. 1977. A preliminary agaric flora of East Africa. Kew Bull. Add. Ser. VI: 1-615.

Pegler DN. 1983. Agaric flora of the Lesser Antilles. Kew Bull. Add. Ser. IX. 1-668. 27 plates.

Pegler DN. 1987. A revision of the *Agaricales* of Cuba 2. Species described by Earle and Murrill. Kew Bull. 42:855-888.

Segedin BP. 1996. A new species of *Lentinellus* (*Hericiales*, *Lentinellaceae*) and a revision of taxa attributed to *Lentinellus* in New Zealand. New Zealand J. Bot. 34: 249-261

Singer R. 1947. New genera of fungi. III. Mycologia 39:77-89.

Singer R. 1955. New *Basidiomycetes*. 47:763-777.

Singer R. 1963. Un hongo nuevo comestible de Sudamerica. Bol. Soc. Argent. Bot. 10: 207-208.

Singer R. 1969. Mycoflora Australis. Beihefte zur Nova Hedwigia 29: 1-405.

Singer R. 1970. Flora Neotropica Monograph No. 3. *Omphalinae* (*Clitocybe-Tricholomataceae*, *Basidiomycetes*). Hafner Publishing Co., New York & London. 84 p.

Singer R. 1973. Diagnosis fungorum novorum Agaricalium. III. Beihefte zur Sydowia 7:1-106.

Singer R. 1975. The *Agaricales* in Modern Taxonomy. 3rd ed., Verlag J. Cramer, Vaduz. 912 p.

Singer R. 1978. Interesting and new species of *Basidiomycetes* from Ecuador. II. Nova Hedwigia 29:1-98.

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th ed. Koeltz Scientific Books, Koenigstein, Federal Republic of Germany. 981 p.

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A distinct species of *Cordyceps* on coleopterous larvae hidden in twigs

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Abstract — A new distinct caterpillar fungus *Cordyceps neosuperficialis* is formally described. Its ascomata grow on coleopterous larvae hidden in small woody twigs and possess obviously superficial perithecia. It was discovered in the Dinghushan Biosphere Reserve, Guangdong Province, China. The holotype (GDGM 24809) is deposited in the Herbarium of Guangdong Institute of Microbiology (GDGM), Guangzhou.

Key words — *Ascomycetes*, *Clavicipitaceae*, *Coleoptera*, new species

Introduction

More than 400 species of *Cordyceps* have been described (Kobayasi & Shimizu 1983, Ito & Hirano 1996). At least 130 species, varieties and formae have been reported in China, and 32 taxa recorded in Guangdong province (Bi et al. 1993, Song et al. 2006). Recently, the authors re-examined some of the materials from Guangdong and discovered that the collections previously labeled as '*Cordyceps superficialis*' from Dinghushan Biosphere Reserve of Guangdong are not completely identical to that American species and are different from any other known taxa. Some new specimens were collected to make further observation and a new species is proposed as follows.

Materials and methods

The description of the new species was based on the examination of the specimens. Herbarium abbreviation follows the Index Herbariorum: GDGM

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[*] corresponding author.

represents the Herbarium of Guangdong Institute of Microbiology. The holotype was deposited in GDGM. The photographs were taken from the holotype. The colour description was according to Kornerup & Wanscher (1978). Tissues were mounted in 5% KOH for microscopic examination. Authors' abbreviations were according to Kirk & Ansell (1992).

Taxonomy

Cordyceps neosuperficialis T.H. Li, Chun.Y. Deng & B. Song, **sp. nov.** **Figs. 1-4**

MycoBank MB 510989

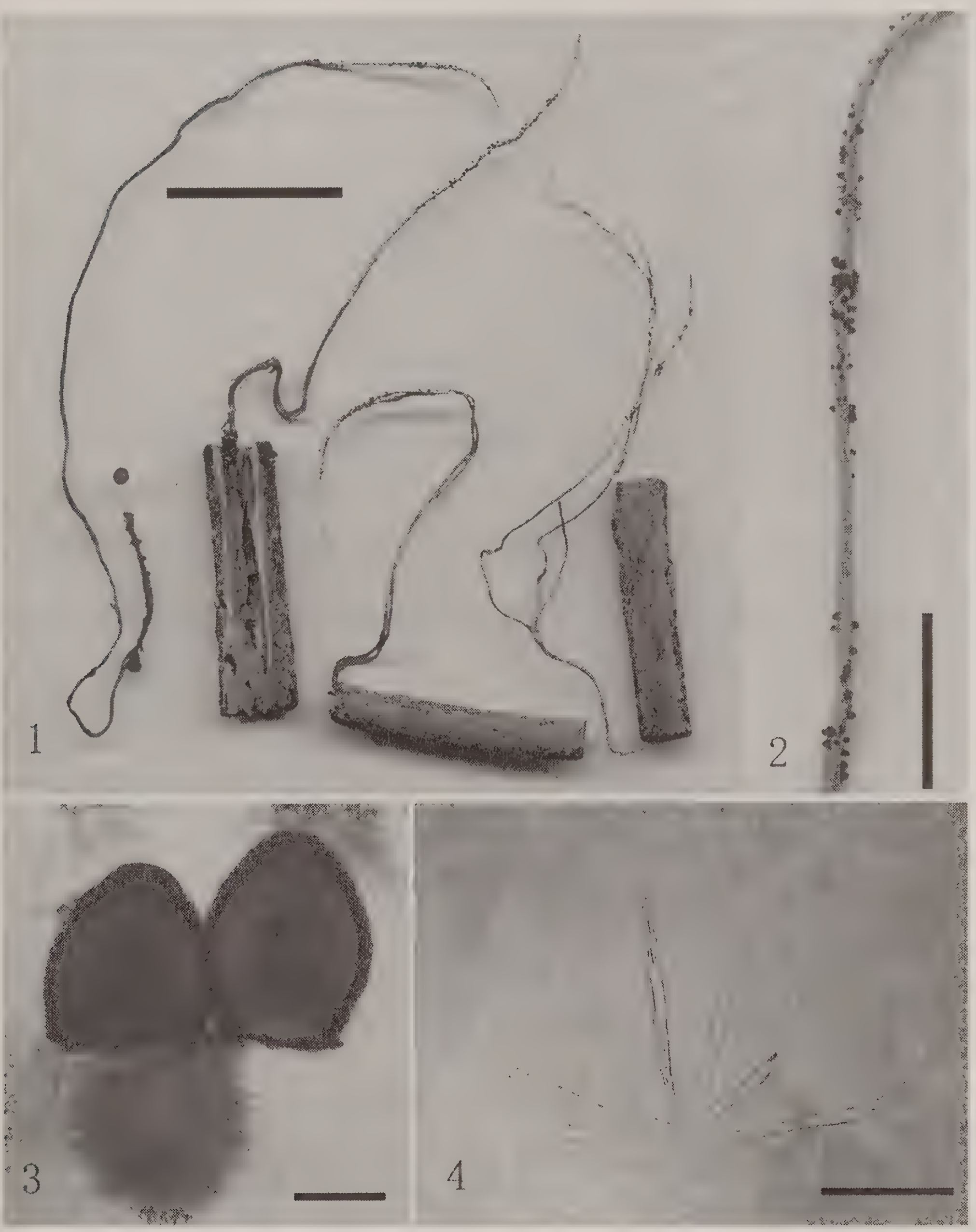
=*Cordyceps superficialis* sensu Bi et al (1983: 118;1993:12);

non *C. superficialis* (Peck) Sacc., Syll. Fung. 2: 574, 1883.

Stroma *ex larvo Coleoptero 1.7-2.5 cm longo et 2-2.5 mm crasso, saepe flexuosum, simplicium vel ramosum, exilis, 6-12 cm longum, 0.5-1.5 mm crassum, dilute aurantiacum, griseo-aurantiacum vel brunneolo-aurantiacum, juvenili apice sterili canum vel subalbidum, perithecis numerosis.* Perithecia *fusca, dense superficialia, ovoidea vel subconica, 220-550 × 220-450 µm.* Asci *helminthoidei, peranguste cylindrici vel filiformes, 145-210 × 4-6 µm, hyalini, terminatione capitulo perlucidulo tumidulo, 8-sporis.* Ascosporae *filiformes, 140-180 × 0.8-1.1 µm, hyalinae, multiseptatae, secedentes, in partisporas 4.5-7.5 µm longas.*

Stroma arising from the head or two ends of host-insects, unbranched to branched, slender, long cylindrical, up to 6-12 cm long, 0.5-1.5 mm thick, usually flexuous, upper portion ashy or pale grey (1B1) when young (perithecia not yet borne), lower and mature portion pale orange, greyish orange to orange brown (5A3, 5B4 to 6B4), colour practically unchanged when dried; fertile portion not swollen, not clearly delimited from sterile portion, up to 6 cm long, gradually tapering upwards, apiculate at terminal, with or without a sterile apex, often with smaller perithecia near apex. Perithecia superficial on superior periphery of stroma, gregarious to caespitose, ovoid to subconical, 220-550× 220-450 µm, usually 400-550 × 400-450 µm when matured, brown, dark orange brown to dark brown (6E5, 6F6 to 6F5), perithecial ostiola slightly exserted, from which spouting white ascospores when matured and humid. Asci helminthoid to narrowly cylindrical or filiform, 145-210 × 4-6 µm, with a transparent crown at apex, acuminate at posterior base, walls gradually broken at maturity, with eight ascospores denuded. Ascospores filiform, slightly shorter than asci, 140-180 × 0.8-1.1 µm, multiseptate, breaking up into 4.5-7.5 µm long part-spores.

Habitat, distribution — On the larvae of *Coleoptera*. The larvae are up to 1.7-2.5 cm long, 2-2.5 mm across, hidden in piths of fallen twigs which were cut off by the insects into small segments measured 2.5-3.5 × 0.4-0.8 cm, usually covered with fallen small branches and leaves in broad-leaf forest. China (Guangdong).



Figs. 1-4: *Cordyceps neosuperficialis* (holotype).
1. Ascomata. 2-3. Perithecia. 4. Asci and ascospores.
Bars: 1=20mm; 2=10mm; 3=200µm; 4=100µm

Collections Examined — CHINA, Guangdong, Dinghushan Biosphere Reserve. 10 May 2007, Li, T. H. & Deng, C. Y. (GDGM 24809; holotype designated here); 27 April 1981, Bi, Z.S. & Li, T. H. (GDGM 4568); 14 May 1981, Bi, Z.S. (GDGM 4811); 23 April 1982, Bi, Z.S. & Li, T. H. (GDGM 6621).

Comments—According to the taxonomic system of Kobayasi (1982), the new species should be placed in Section *Racemella* under Subgenus *Eucordyceps*. Among the known taxa, four species are quite similar to the new species in the characters of slender stroma and superficial perithecia, and their differences are pointed out below. As compared with the new species, the American species *C. superficialis* possesses much shorter and darker stroma and obviously larger perithecia and part-spores (Saccardo 1883, Ellis 1892, Shimizu 1997); another American taxon, *C. michiganensis* Mains, has paler perithecia and much longer part-spores (Mains 1934, Shimizu 1997); the Asian caterpillar fungus, *C. agriota* A. Kawam. from Japan, has a acicular stroma and darker blackish perithecia (Kobayasi & Shimizu 1983, Shimizu 1997); the second Asian species, *C. mrciensis* Aung et al. from Thailand arising from spider, produces smaller perithecia, thicker asci, and ascospores that do not break into part-spores (Aung et al. 2006).

The most distinct macroscopic character of the new species is that its host larvae were hidden in piths of fallen twigs, which were cut off by the insects into small segments. Specimens cited above for the new species were originally misidentified as *C. superficialis* (Bi et al. 1983, 1993), but re-examination showed that no specimens completely identical to that American species have been found in China.

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Literature cited

Aung OM, Kang JC, Liang ZQ, Soytong K, Hyde KD. 2006. *Cordyceps mrciensis* sp. nov. from a spider in Thailand. Mycotaxon 97: 235-240

Bi ZS, Li TH, Li C. 1983. A primary survey on *Cordyceps* in Dinghu Mountain. Microbiology 10(3): 118.

Bi ZS, Zheng GY, Li TH. 1993. The Macrofungus Flora of China's Guangdong Province. The Chinese University Press: Hong Kong(China): 734 p.

Ellis JB, Everhart BM. 1892. The North American Pyrenomycetes. Private printing: Newfield, New Jersey (USA): 793 p.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I: herbaria of the world. 8th edition. New York Botanical Garden: New York (USA).

Ito Y, Hirano T. 1996. First successful amplification of 18S ribosomal DNA of *Cordyceps* spp. by the PCR methods. Mycoscience 37: 109-110

Kirk PM, Ansell AE. 1992. Authors of fungal names. Index of Fungi Suppl. Wallingford: CAB. International.

Kobayasi Y. 1982. Keys to the taxa of the genera *Cordyceps* and *Torrubiella*. Transaction of the Mycological Society of Japan, 23: 329-364.

Kobayasi Y, Shimizu D. 1983. Iconography of vegetable wasp and plant worms. Hoikusha. Publ. Co. Ltd.: Osaka (Japan): 280 p.

Kornerup A, Wanscher JH. 1978. Methuen Handbook of Colour. 3th edn., Eyre Methuen: London (UK). 252 p.

Mains EB. 1934. The Genera *Cordyceps* and *Ophiocordyceps* in Michigan. Proceeding of the American Philosophical Society 74(4): 263-271..

Saccardo PA. 1883. Sylloge Fungorum Omnium Hucusque Cognitorum Digessit. Vol. 2. Patavii (Padua): 574 p.

Shimizu D. 1997. Iconography of vegetable wasps and plant worms. Horikusha Publ. Co. Ltd.: Tokyo (Japan). 446 p.

Song B, Lin QY, Li TH, Shen YH, Li JJ, Luo DX. 2006. Known species of *Cordyceps* from China and their distribution. Journal of Fungal Research. 4(4): 10-26.

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Cordyceps guangdongensis sp. nov. from China

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Abstract—A new species of *Cordyceps* discovered in Guangdong of China, *Cordyceps guangdongensis*, is formally introduced. The fungus grows on *Elaphomyces* sp. in a broadleaf forest. The closest species is *C. japonica*, but these are different in sizes of perithecia and part spores, and with only 93.9% sequence similarity of ITS1-5.8S-ITS2 region. The holotype is deposited in the Herbarium of Microbiology Institute of Guangdong Province.

Key words—*Ascomycetes, Clavicipitaceae,* mycogenous fungi

Introduction

Cordyceps is a megagenus that contains about 450 species, including 32 species parasitic on hypogeous fungi, mainly *Elaphomyces* (Stensrud et al. 2005, Kobayasi & Shimizu 1983). However, some names are treated as taxonomic synonyms. There are about 130 taxa of *Cordyceps* reported in China, including 7 species and 1 forma associated with *Elaphomyces* (Liang 2007, Song et al. 2006). Guangdong Province, located in the south of China, is rich in *Cordyceps* species. More than 30 species of the genus occurring there have been recorded (Song et al. 2006, Bi et al. 1993). In an investigation of the Erhuangzhang Nature Reserve, Yangchun County, Guangdong Province, collections of a *Cordyceps* species parasitic on *Elaphomyces* sp. was discovered. It turns out to be a new species and is formally described.

Materials and methods

Specimens and isolates

Morphological and molecular data were obtained from fresh and dried specimens collected from Erhuangzhang Nature Reserve. Specimens are deposited in the Herbarium of Microbiology Institute of Guangdong Province (GDGM). The isolate of *C. japonica* Lloyd (IFO9647) was from the culture collection at the Institute for Fermentation, Osaka, Japan, maintained on PDA medium (potato 200g/L, glucose 20g/L, agar 20g/L). Liquid culture with YMPD medium (glucose 10g/L, polypeptone 5 g/L, yeast extract 3 g/L, malt extract 3g/L) was performed at 20-25 °C, with a shake speed of 150r/m. Mycelia were harvested, washed with sterile water for 2-3 times, and squeezed to dry for DNA extraction.

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*Corresponding author

Morphological observations

Ten stromata of the specimens were measured. Color descriptions followed Kornerup & Wanscher (1978). Micro-anatomical characters were studied with light microscopy. 40 perithecia, 40 part spores, and 20 asci were measured. Perithecia, asci and part-spores were respectively measured and pictured at magnifications of ×100, ×400, ×400 or ×1000. Authors' abbreviations were according to Kirk & Ansell (1992).

DNA extraction, amplification and sequencing

Genomic DNA was extracted from dried specimen and fresh mycelia followed the benzyl chloride method (Zhu et al. 1994). To eliminate the interference of RNA, RNAse (20ng/μl) was added to the DNA solution and bathed at 37°C for 30 min. DNA examples were checked on 1.0% agarose.

The PCR amplification was performed on a T3000 Thermocycler (Biometra, Germany), with a total of 50μl reaction mixture, containing 5μl 10× buffer with 25mM $MgCl_2$, 2μl 10mM dNTPs, 2μl 10mM ITS4, 2μl 10mM ITS5, 0.4μl 5U/μl Taq polymerase, 2μl 50× diluted DNA template and 36.6μl double distilled water. The cyclic thermal program was as follows: an initial 4 min denaturation at 95 °C; 30 cycles of 1 min at 94 °C, 40s at 55 °C, 1.5 min at 72 °C, and termination with a 6 min elongation at 72 °C. A negative control (ddH_2O) was included. 5μl product was determined by electrophoresis with 1.0% agarose. Sequencing was finished by Guangzhou Top Genomics, Ltd., with TA clone. Sequences were submitted to GenBank.

Data analysis

DNA sequences of the new species and *C. japonica* were tested with BLAST in GenBank. According to the sequence similarities, 10 sequences of the closest species were retrieved from GenBank for construction of the consensus tree with *C. militaris* as outgroup. Their Genbank Accession numbers were listed in Table 1. The 11 ITS1-5.8S-ITS2 sequences were selected with BioEdit referring to the sequence of the new species. Preliminary multiple alignments were generated with ClustalX 1.83. The phylogenetic tree was constructed with MEGA3.1 (Kumar et al. 2004). Neighbor-joining method was performed

Table 1. Sequences used in phylogenetic tree construction

SPECIES	GENBANK ACCESSION NO
C. capitata	AJ786557
C. guangdongensis	EU039881
C. inegoensis	AB027368
C. japonica	EU039882
C. jezoensis S. Imai	AB027365
C. longisegmentis Ginns	AJ786568
C. militaris (L.) Link	AJ786569
C. ophioglossoides	AJ786586
C. paradoxa	AB027369
C. subsessilis	AJ786599
Tolypocladium cylindrosporum W. Gams	AB208110
T. inflatum W. Gams	AJ786592

in MEGA3.1, selecting the 'complete deletion' mode to consider deletions. Confidence values for individual branches were determined by bootstrap analysis (1000 replications). Four sequences of ITS1-5.8S-ITS2 were selected based on phylogenetic study and morphological similarity. Their similarity was compared using BioEdit.

Results

Taxonomy

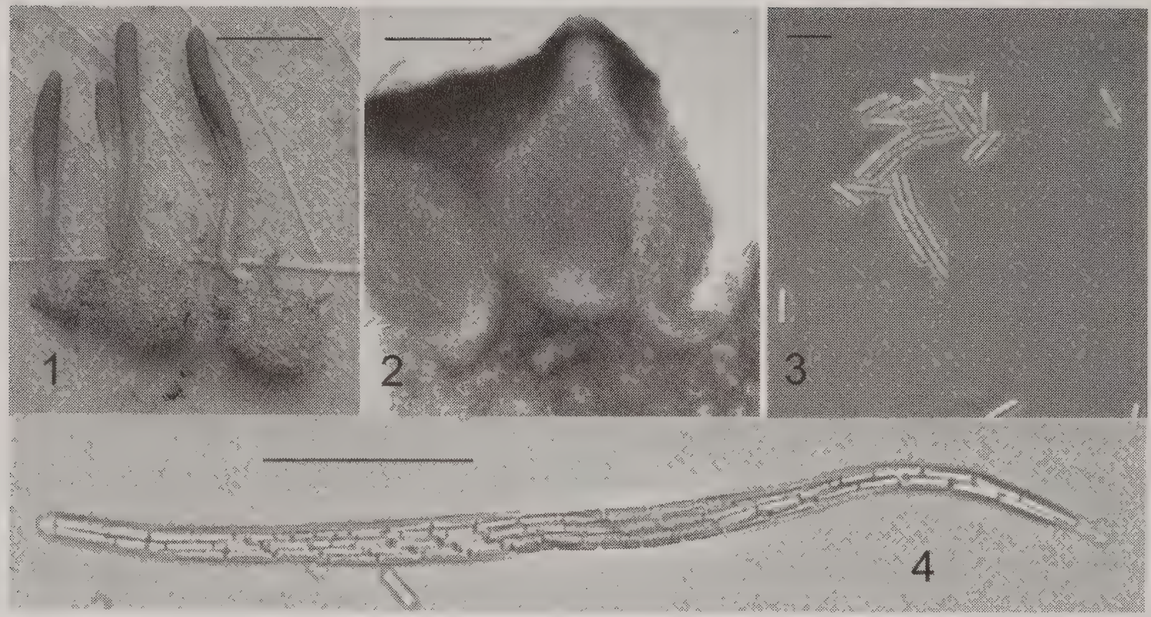
Cordyceps guangdongensis T.H. Li, Q.Y. Lin & B. Song, **sp. nov.** **Figs. 1-4**

MycoBank MB 511126

≡ *Cordyceps japonica* f. *guangdongensis* T.H. Li, Q.Y. Lin & B. Song (nom. nudum), in Song et al., Journal of Microbiology 27(1): 60, 2007.

STROMATA solitaria vel plures ex Elaphomycete, simplicia, cylindrica vel clavata, 3-7 cm longa, carnosa. Area fertilis terminalis, cylindrica, 1-3 cm longa, 5-8 mm crassa, olivacea, olivaceo-brunnea vel sepiacea. Stipes cylindricus, 2-4 cm longus, 4-6 mm crassus, olivaceo-luteus, olivaceo-griseus vel griseus. PERITHECIA dense immersia, ellipsoidea vel ovoidea, 245-495 × 160-320 μm. ASCI helminthoidei, 195-270 × 7-10 μm, 8-ascosporis. ASCOSPORAE levis, filiformes, 180-260 × 2.0-3.7 μm, multiseptatae, in partisporas 10-17 μm longas.

STROMATA 1 to 3 in a group arising from fruitbodies of ELAPHOMYCES sp., cylindrical to clavate, 3-7 cm long, tender fleshy; upper fertile portion cylindrical, rounded at top, 1-3 × 0.5-0.8 cm, olive, dark olive, olive brown to golden gray or brownish gray (3E3, 3F3, 4F3 to 4F4), sometimes furrowed at lower part, without a sterile apex; perithecial ostiola punctiform, not protruding from surface of stroma; lower sterile portion 2-4 × 0.4-0.6 cm, color varied from yellowish gray, olive, grayish olive, olive-gray to gray (3C2, 3C3, 3C4 to 3D4), usually paler at base and near fertile portion which is light yellow to grayish



Figs. 1-4. *Cordyceps guangdongensis* 1. Stromata (bar = 3cm). 2. Perithecia (bar = 200µm). 3. Part spores (bar= 15µm). 4. Ascus (bar= 50µm). All from holotype.

yellow or dull yellow (3A5, 3B4-3B7) and then becoming yellowish gray, olive gray to gray (3D1, 3D2 to 3D3), with white mycelium around the base and part of substrate. Perithecia deeply embedded in stroma, ellipsoid to ovoid, 245-495 × 160-320 µm. Asci helminthoid, 195-270 × 7-10 µm, with a transparent and slightly swollen crown 3.5-5.0 × 5.0-7.0 µm at apex, acuminate at posterior end, 8-spored. Ascospores 180-260 × 2.0-3.7 µm, filiform, multiseptate, breaking up into part spores; part spores 10-17 µm long, with truncated ends.

Habitat —scattered to gregarious on *Elaphomyces* sp. buried in soil in broadleaf forest.

> Specimens examined —China, Guangdong Province, Yangchun County, Erhuangzhang Nature Reserve, alt. 50 m, 23 IV 2005, Li T.H., Wu L.M., Chen M.B. & Huang H., (GDGM 24020; holytype); 2 V 2006, alt. 50 m, Li T.H., Lin Q.Y. & Huang H. (GDGM 24851).

Sequence analysis

The ITS1-5.8S-ITS2 sequences of *C. guangdongensis* and *C. japonica* (GenBank Acc. No. EU039882) had 611 bp and 626 bp respectively. Sequence of *C. japonica* obtained in this study is almost identical with that by Stensrud et al. (2005) (GenBank Acc. No.: AB027366), only with two different base pairs, while *C. guangdongensis* and *C. japonica* are with 36 different base pairs. In analysis of the ITS sequence, the similarity between *C. guangdongensis* and *C. japonica* is 93.9% (Table 2). Although they are closely related as shown in the consensus tree, their genetic distance is the same as that between *C. inegoensis* Kobayasi and *C. paradoxa* Kobayasi, as well as that between *C. subsessilis* Petch and *C. ophioglossoides* (Ehrh.) Link (Fig. 5).

Table 2. Similarity matrix of ITS sequences of four *Cordyceps* species

Taxa	*C. guangdongensis*	*C. japonica*	*C. jezoensis*	*C. ophioglossoides*
C. guangdongensis	—			
C. japonica	93.9%	—		
C. jezoensis	89.3%	87.4%	—	
C. ophioglossoides	73.4%	71.4%	77.3%	—

Discussion

Among the *Cordyceps* species parasitic on *Elaphomyces* spp., including the well known *C. ophioglossoides* and *C. capitata* (Holmsk.) Link, the most similar species, morphologically, to the new species is *C. japonica*. However, the two species are distinctively different in the size of perithecia and partial spores. Both the perithecia (500-550 × 200-250µm) and the part spores (10-25 × 2.5-3.0µm) of *C. japonica* (Kobayasi &Shimizu 1983) are longer than those of the new species. According to the study based on analysis of ITS sequences from 32 specimens of seven *Cordyceps* species, sequences of the same species from different localities are almost invariable (Stensrud et al. 2005). In this study, the ITS sequences of *C. guangdongensis* and its closest species *C. japonica* have 36 different base pairs. The 93.9% sequence similarity and obvious genetic distance indicate that they are different species.

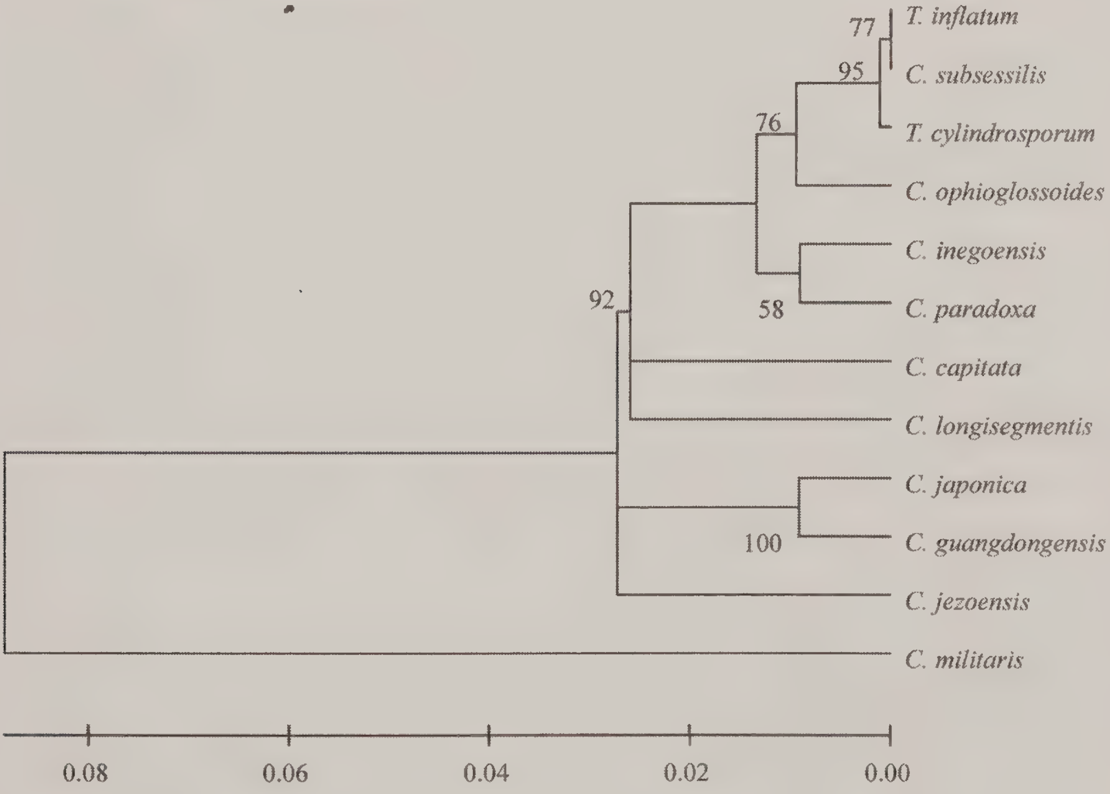

77
95
76
92
58
100
T. inflatum
C. subsessilis
T. cylindrosporum
C. ophioglossoides
C. inegoensis
C. paradoxa
C. capitata
C. longisegmentis
C. japonica
C. guangdongensis
C. jezoensis
C. militaris
0.08
0.06
0.04
0.02
0.00

Fig. 5. Consensus tree, based on ITS sequences of 12 taxa of *Cordyceps*.

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Literature cited

Bi ZS, Zheng GY, Li TH. 1993. The Macrofungus Flora of China's Guangdong Province. The Chinese University Press: Hong Kong (China) 734 p.

Kirk PM, Ansell AE. 1992. Authors of fungal names. Index of Fungi Suppl. Wallingford: CAB. International.

Kobayasi Y, Shimizu D. 1983. Iconography of vegetable wasp and plant worms. Hoikusha. Publ. Co. Ltd.: Osaka (Japan) 280 p.

Kornerup A, Wanscher JH. 1978. Methuen Handbook of Colour. 3rd edn., Eyre Methuen: London (UK) 252 p.

Kumar S, Tamura K, Nei M. 2004. MEGA3: Integrated software for molecular evolutionary genetics analysis and sequence alignment. Briefings in Bioinformatics 5(2):150-163.

Liang ZQ. (ed.) 2007. Flora Fungorum Sinicorum, (Vol.32, *Cordyceps*). Beijing: Science Press (China) 190 p.

Song B, Lin QY, Li TH, Shen YH, Li JJ, Luo DX. 2006. Known species of *Cordyceps* from China and their distribution. Journal of Fungal Research 4(4): 10-26.

Stensrud Ø, Hywel-Jones NL, Schumacher T. 2005. Towards a phylogenetic classification of *Cordyceps*: ITS nrDNA sequence data confirm divergent lineages and paraphyly. Mycological Research 109(1): 41-56.

Zhu H, Qu F, Zhu L. 1994. Isolation of genomic DNAs from fungi using benzyl chloride. Acta Mycologica Sinica 13(1): 34-40.

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A study of the types and additional materials of *Clitocybe pseudophyllophila* and *Clitocybe subcandicans*

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Abstract — The holotypes and additional materials of *Clitocybe pseudophyllophila* and *C. subcandicans*, originally described from China in 1985, were critically restudied. New evidence proved that they should be placed under *Clitopilus* for their pinkish basidiospores with longitudinal ridges. All re-examined specimens labeled as *C. pseudophyllophila* and *C. subcandicans* were identical to *Clitopilus crispus*.

Key words — *Agaricales*, taxonomy, revision

Introduction

Some clitocybeoid species of *Clitopilus* (Fr. ex Rabenh.) P. Kumm. are macroscopically similar to those of *Clitocybe* (Fr.) Staude; however, their basidiospores obviously differ. Basidiospores of *Clitocybe* are smooth, while those of *Clitopilus* are longitudinally ridged (Singer 1986). The two genera can be possibly confused if the characters of basidiospores have not been observed carefully. Recently the authors critically re-examined the holotypes and additional materials of *Clitocybe pseudophyllophila* and *Clitocybe subcandicans* originally described from Guangdong Province of China. The results show that both represent a species of *Clitopilus* with pinkish longitudinally ridged basidiospores. Therefore, detailed description based on the re-examination is presented and the taxonomic status is discussed as follows.

Materials and methods

The specimens examined are preserved in GDGM (Herbarium of Guangdong Institute of Microbiology, Guangdong Province, China). Herbarium abbreviation follows Holmgren & Holmgren (1998).

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*corresponding author

Tissues were mounted in 5% aqueous KOH for microscopic examination. The abbreviation [n/m/p] designates *n* basidiospores measured from *m* basidiomata *in* p collections. Dimensions of basidiospores including the apiculus are given with notation of the form (a)b–c(d). The range b–c contains a minimum of 90% of the measured values with the outliers a and d given in parentheses. Q refers to the basidiospore length/width ratio; **Q** refers to the average Q of all basidiospores ± sample standard deviation. Scanning electron micrographs were produced with a FEI-XL30 scanning electron microscope (SEM) generally running at 10 kev.

Taxonomy

1. *Clitocybe pseudophyllophila* Z.S. Bi & G.Y. Zheng, Guihaia 5: 364, 1985

Figs. 1–2

Basidiomata (fig. 1) small to medium in size. Pileus 2–6 cm broad, convex to applanate, often slightly depressed at centre, white to chalk white; margin incurved, finely subfimbriate, with radial fine ridges extending nearly halfway to the disc. Context white. Lamellae 2–3 mm wide, decurrent, white or cream-coloured to pinkish. Stipe 2–6 × 0.3–0.8 cm, subcylindrical, central to excentric, white, smooth, sometimes finely fibrillose, especially at base.

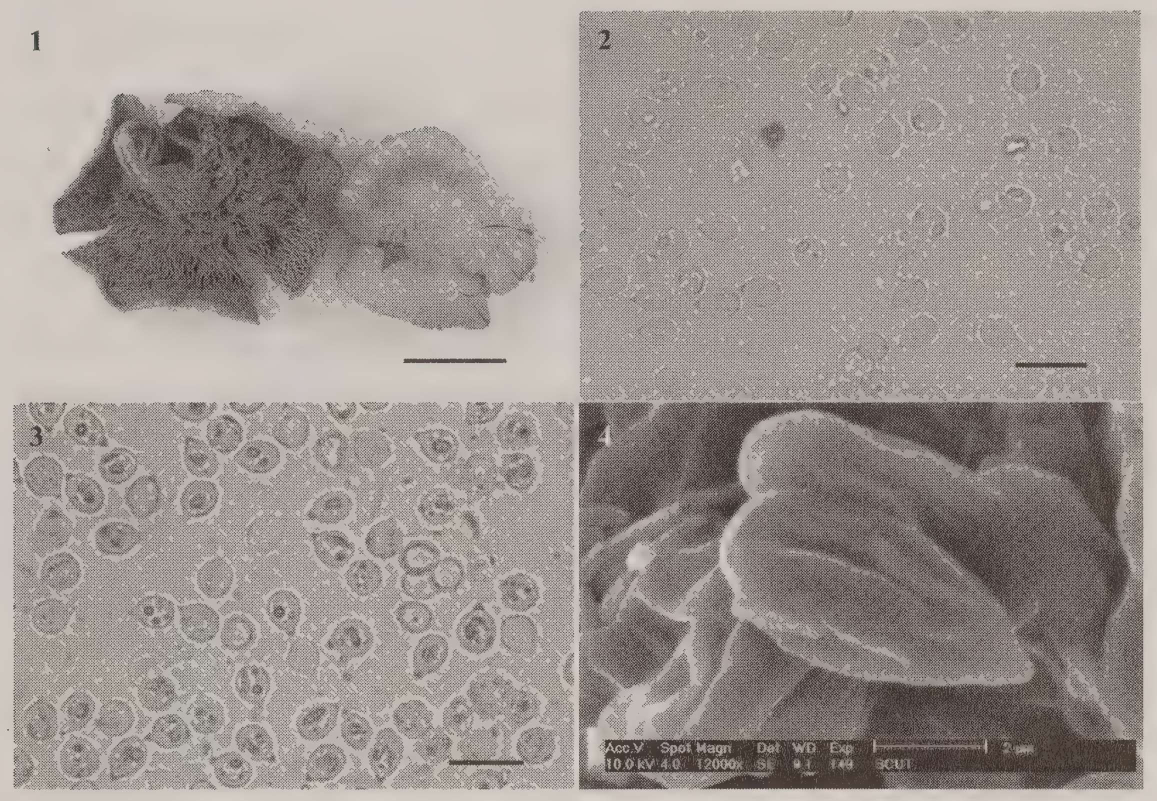
Basidiospores (fig. 2) [175/10/5] (5.9–)6.8–8.5(–9.6) × (4.0–)4.5–5.5(–6.0) µm [Q = (1.20–)1.30–1.60(–1.70), **Q** = 1.52 ± 0.13], ovoid, broadly ellipsoid to ellipsoid in profile and face view, angled in polar view with 9–11 facets, longitudinally ridged. Basidia 15–24 × 6.4–8 µm, clavate, 4-spored, rarely 1-, 2- or 3-spored; sterigmata about 3 µm long. Subhymenium consisting of short segments, 2–5 µm wide. Hymenophoral Trama more or less regular, with thin-walled hyphae 3–7 µm wide. Pleurocystidia and cheilocystidia absent. Clamp Connection absent.

Habitat: on soil in broad-leaved forest.

specimens examined—CHINA, Guangdong Province, Guangzhou, Huanghuagang Park, 5.VIII. 1983, W.L. Zheng [holotype, GDGM-6027]; ibid, 2. IV. 1984, T.H. Li [GDGM-6148]; ibid, 2. IV. 1984, Z.S. Bi [GDGM-6309]; ibid, 16. VII. 1984, T.H. Li [GDGM-6340]; Guangzhou Zoological Garden, 26. IV. 1984, T.H. Li [GDGM-6201].

2. *Clitocybe subcandicans* Z.S. Bi, Guihaia 5: 365, 1985 Figs. 3–4

Basidiomata small in size. Pileus 0.8–2.1(–4) cm broad, convex to applanate, often slightly depressed at centre, white to chalk white; margin incurved, finely subfimbriate, with radial fine ridges extending nearly halfway to the disc. Context white. Lamellae decurrent, white. Stipe 1.2–4.0 × 0.1–0.7 cm, subcylindrical, central to excentric, white, smooth, sometimes finely fibrillose, especially at base.



Figs. 1-2: *Clitocybe pseudophyllophila* (holotype). 1. Basidiomata (dry material). 2. Basidiospores in LM; **Figs. 3-4:** *Clitocybe subcandicans* (holotype). 3. Basidiospores in LM. 4. Basidiospores in SEM.
Bars: 1 = 1cm; 2 = 10 μm; 3 = 10 μm; 4 = 2 μm

The microscopic characters (Fig. 3–4) of the specimens are practically the same as those of *C. pseudophyllophila*.

HABITAT: on soil in broad-leaved forest.

SPECIMENS EXAMINED—CHINA, GUANGDONG PROVINCE, ZHAOQING COUNTY, Dinghushan Biosphere Reserve, 16.IV. 1981, T.H. Li [HOLOTYPE, GDGM-5478]; ibid, 3. IV. 1981, J.Q. Liang [GDGM-4428]; ibid, 17.VII. 1980, Z.S. Bi [GDGM-4387]; ibid, 8. VIII. 1981, T.H. Li [GDGM-5320].

REMARKS — The longitudinal ridges (Fig. 4) on the basidiospores of *C. pseudophyllophila* and *C. subcandicans* indicate that they represent a species of *Clitopilus*. Their main characters, including the white pileus with radial fine ridges at margin as well as the ovoid, broadly ellipsoid to ellipsoid basidiospores with 9–11 facets and (5.9–)6.8–8.5(–9.6) × (4.0–)4.5–5.5 (–6.0) μm in size, are identical to those of *Clitopilus crispus* Pat. (Patouillard 1913, Baroni & Watling 1999, Yang 2000). Therefore, *C. pseudophyllophila* and *C. subcandicans* should be placed as synonyms with *C. crispus*.

The specimens cited above were misidentified as species of *Clitocybe* because the longitudinal ridges on their basidiospores were overlooked. Bi & Zheng

(1985) considered that *C. pseudophyllophila* was different from *C. subcandicans* in spore print colour, i.e., pinkish in *C. pseudophyllophila* and white in *C. subcandicans*. However, recent observation showed that the basidiospores from type specimen of *C. subcandicans* were pinkish as well. The reason for the mistake might be that the specimens were young and, thus, the pinkish colour of lamellae and spore print was not so obvious with less mature spores.

C. crispus was first described from Vietnam (Patouillard 1913). It was reported for the first time from China by Yang (2000). Yang & Zang (2003) considered that the species is a tropical Asian element. While re-examining the specimens of *Clitopilus* in China, the present authors found that it was quite common in tropical Yunnan and Guangdong. There are also some similar species with white to whitish basidiomata occurring in tropical Asian areas, including *C. apalus* (Berk. & Broome) Petch var. *apalus*, *C. amygdaliformis* Zhu L. Yang, and *C. orientalis* T.J. Baroni & Watling. A detailed comparison among them has been made by Yang (2007).

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Literature cited

Baroni TJ, Watling R. 1999. Taxonomic and mycogeographic notes on some Malaysian fungi IV. Notes on *Clitopilus* and *Rhodocybe*. Mycotaxon 72: 57–72.

Bi ZS, Zheng GY. 1985. Notes concerning the subdivision of *Clitocybe* and three new species from Guangdong. Guihaia 5: 363–368.

Holmgren PK, Holmgren NH. 1998. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum. nybg.org/ih/

Patouillard N. 1913. Quelques champignons du Tonkin. Bull. Soc. Mycol. France 29: 206–228.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4th edit. Koeltz Scientific Books: Koenigstein (Germany).

Yang ZL. 2000. Notes on five common but little known higher Basidiomycetes from tropical Yunnan, China. Mycotaxon 74: 45–56.

Yang ZL. 2007. *Clitopilus amygdaliformis*, a new species from tropical China. Mycotaxon 100: 241–246.

Yang ZL, Zang M. 2003. Tropical affinities of higher fungi in southern China. Acta Botanica Yunnanica 25: 129–144.

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Ţura, Daniel, Wjacheslav A. Spirin, Ivan V. Zmitrovich, Solomon P. Wasser & Eviatar Nevo. Polypores new to Israel — 1: Genera *Ceriporiopsis*, *Postia*, and *Skeletocutis.* 103: 217–227. 2008.

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p.150, lines 8–9	for: *P. dysthales* forma *keralense* Manim. & Noordel. read: *Entoloma dysthales* var. *keralense* Manim. & Noordel.
p.331, line 23	*for:* Castellano MA, Smith JE, O'Dell T, Cázares E, Nugent S. 2003. *read:* Castellano MA, Cázares E, Fondrick B, Dreisbach T. 2003.

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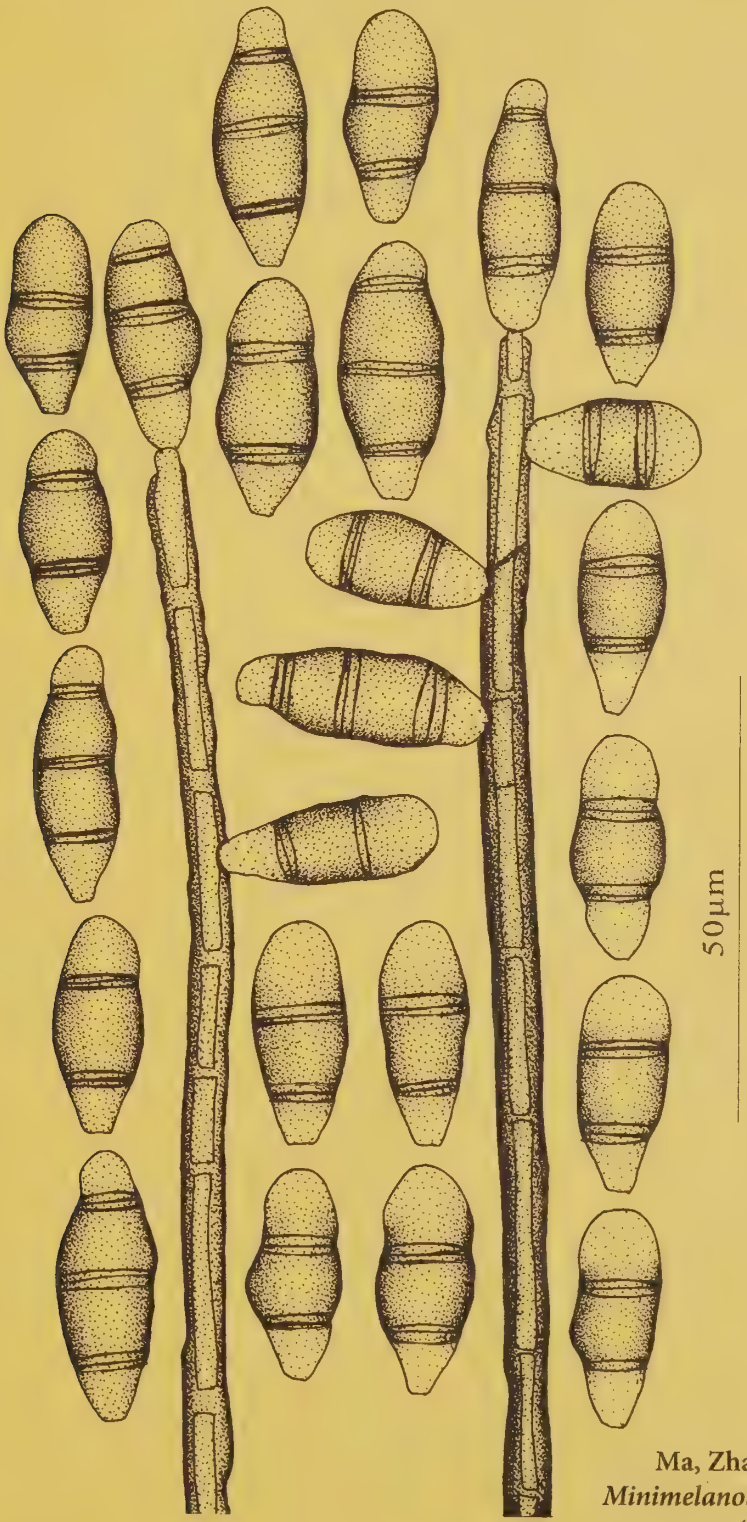

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Minimelanolocus endospermi
sp. nov. (p. 148, Fig 1.)

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On *Cheimonophyllum candidissimum* from Greece with notes on its implied aphyllophoroid ancestry

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Abstract — *Cheimonophyllum candidissimum* is newly recorded from Greece and this is one of the very few records from the Mediterranean region. This is also the first report of the species on *Platanus orientalis.* Macroscopic and microscopic descriptions are given, as well as taxonomic and biogeographical comments, and a discussion on morphology with implications concerning the nature of the cystidioid elements and their possible ancestry.

Key words — lignicolous fungi, hyphidia, *Tricholomataceae, Gloeostereum*

Introduction

Cheimonophyllum Singer is a small genus in the family *Tricholomataceae,* comprising only three species to date. A recent molecular study (Moncalvo et al. 2002) places *Cheimonophyllum* in the same clade as *Gloeostereum,* with the nearest clade containing *Baeospora* and *Hydropus.*

The main distinctive characters of the genus are: basidiocarps lignicolous, pleurotoid, small, white; stipe absent or short, lateral; basidiospores hyaline, globose to subglobose, inamyloid; cheilocystidia filamentous (Singer 1986).

In the field, *Cheimonophyllum candidissimum* is a look-alike of *Panellus mitis, Clitopilus hobsonii* or various *Crepidotus* species, although the microscopical features of these species are strikingly different. Its distribution is wide, almost cosmopolitan, but, in most cases, its occurrence is uncommon if not rare.

Materials and methods

Microscopical observations were made in bright field and phase contrast using a standard light transmission microscope as well as a Differential Interference Contrast (DIC) microscope. Sections of dried material were mounted in 3% KOH and Melzer's reagent. All measurements were performed under 1000× magnification. At least 20 spores and 10 basidia and cheilocystidia were measured per specimen. Spore sizes are given in approximation to 0.5 µm, with extreme values given in parentheses, followed by the length-width ratio of the spores (Q). The description and habitat reference given refer exclusively to the material collected from Greece. Specimens from other countries were also examined. Greek localities are transcribed into Latin according to ISO 843: 1997 (E). Authorities' abbreviations are in accordance to Authors of Fungal Names by Kirk & Ansell (1992). The collected specimen is deposited at the Mycological Herbarium of the University of Athens (ATHU-M). The loaned specimens are kept in Zürich (Z+ZT).

Taxonomic description

Cheimonophyllum candidissimum (Berk. & M.A. Curtis) Singer
Sydowia 9: 417 (1955)

Pileus 2–17 mm, convex to plano-convex, cyphelloid to flabelliform, laterally attached to the substrate, with straight or incurved margin, pure white; surface dry, smooth, minutely pubescent towards the point of attachment. Lamellae whitish to ivory in fresh specimens, cream colored when dried, moderately crowded to rather distant, radiating from the point of attachment. Stipe rudimentary or absent.

Basidiospores (5.0–)5.5–7.0 × (4.5–)5.0–6.5 µm, Q = 1.00–1.20 (–1.40), globose to subglobose, with a distinct apiculus, thin-walled, hyaline, smooth, inamyloid, with granular content or few oil droplets, occasionally fusing to one big oil droplet (Figs 1a; 3b). Basidia 20–31 × 7–9 µm, clavate, 4-spored, rarely 2-spored, with basal clamp; content granular or with numerous oil droplets (Figs 1b; 3c). Cheilocystidia 40–110 × 2–4 µm, filiform, some with a slightly swollen base, branched or not, often multiply so, some septate and clamped; apices acute, often markedly thin, less than 1 µm wide (Figs 1c; 3e–i). Pleurocystidia absent but rarely some clavate cystidioid bodies present with apical or apico-lateral outgrowths (Fig. 3d). Lamellar margin sterile or heterogeneous (Figs 2; 3j). Lamellar trama regular; hyphae 1.5–4 µm wide, more or less parallel, slightly thick-walled. Pileipellis an entangled trichodermium; hyphae 1.5–3 µm wide. Context of loosely interwoven hyphae 2–5 µm wide, hyaline, slightly thick-walled. Clamp connections present in all tissues, conspicuous, abundant.

Habitat: Gregarious on fallen branches of *Platanus orientalis*. November. In Greece known only from a single site.

Specimens examined — **Greece:** Granitsa, Evrytania, 39°06'N, 21°31'E, alt. *ca* 700 m, stands of *Platanus orientalis*, on fallen branches of *P. orientalis*, 11 Nov. 2004, Delivorias, ATHU-M 5467; **Estonia:** Valga, Mehiksoo, on *Populus tremula*, 22 Nov. 1982, Veldre, TAA 114978; **Canary Islands:** Tenerife, Altos de la Matanza, 11 Jan. 1984, Beltran, TFC Mic 2211; **Switzerland:** Ormont-Dessus, Les Diablerets, alt. 1260 m, mixed hardwood

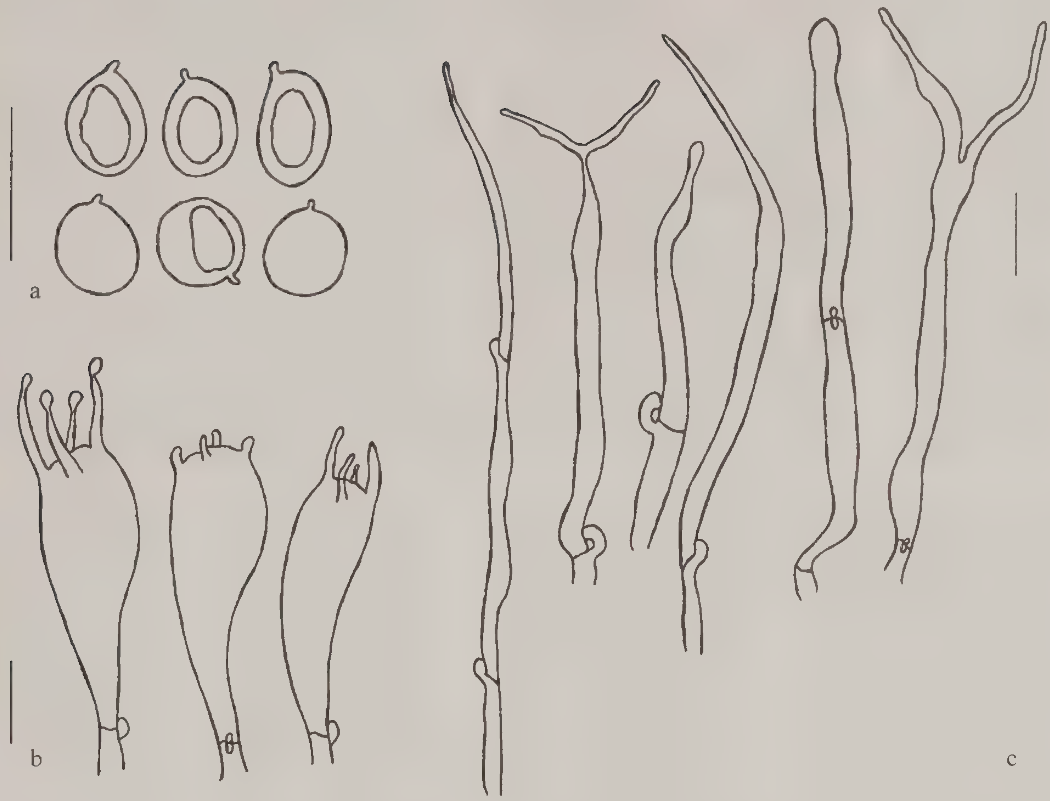

Fig. 1. *Cheimonophyllum candidissimum:* **a.** Basidiospores, **b.** Basidia, **c.** Cheilocystidia. Bars = 10 µm.

forest, 17 Sep. 1992, Senn-Irlet, Herb. Helv. 92/222; Gurnigel-Berghaus, subalpine spruce forest, on dead *Sorbus aucuparia,* 27 Sep. 1995, Senn-Irlet, Herb. Helv. 95/115; **France:** Dpt. Ardennes, Rocroi – Bois des Hingues, 15 Sep. 1993, mixed hardwood forest, on moss-covered branch, Senn-Irlet, Herb. Helv. 93/56.

REMARKS: *C. candidissimum* is recognized by the minute, laterally attached to the substrate, pure white basidiocarps with somewhat distant lamellae (Fig. 3a), and the white, globose to subglobose, inamyloid basidiospores. It is macroscopically similar to young specimens of *Panellus mitis, Clitopilus hobsonii* or several species of *Crepidotus.*

Segedin (1994) reports 1-, 2- and 4-spored basidia, and Senn-Irlet (1990) reports mostly 4-spored basidia or (for one collection) with 2- and 4-spored basidia intermixed. The great majority of basidia in our specimen were 4-spored; a few 2-spored basidia were also encountered but seemed very rare. The same applies to the specimens we examined from other countries, kindly provided to us by Senn-Irlet, with one notable exception: in specimen TAA 114978 from Estonia, 2-spored basidia were quite common, if not dominant (Fig. 3c). Some 1-spored basidia were also observed in this specimen.

Senn-Irlet (1990) provides an interesting discussion on the characterization of the elements at the lamellar margin, questioning their origin, and retaining

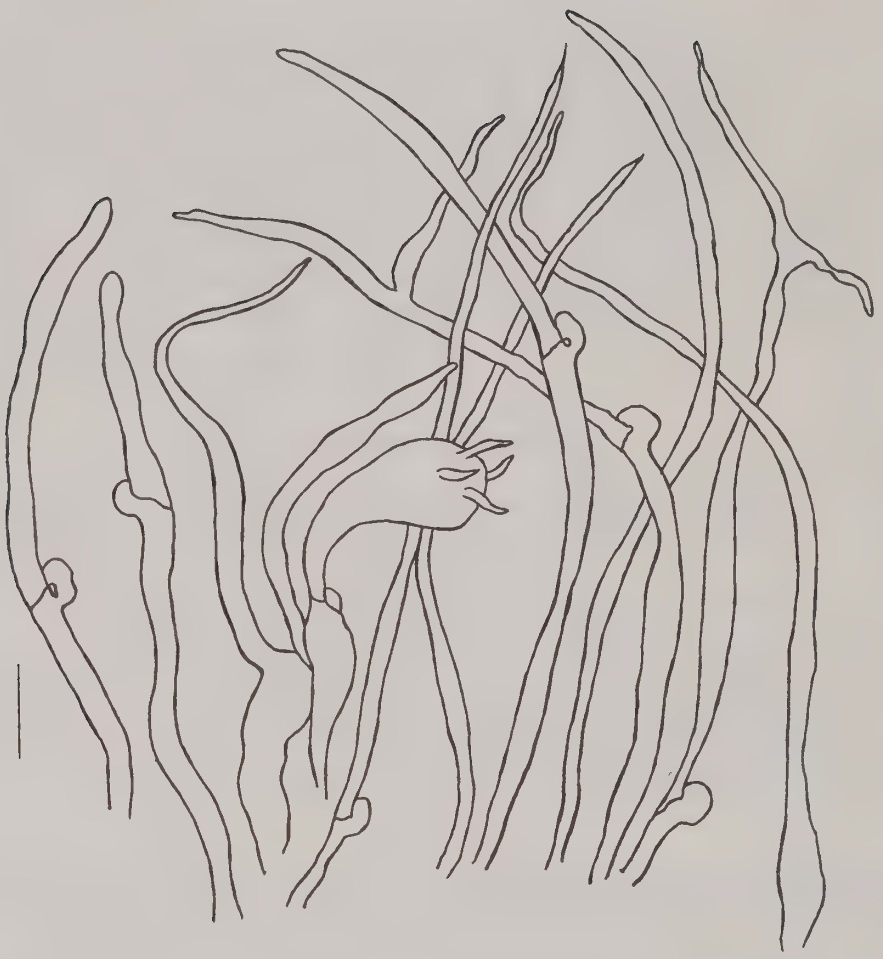

Fig. 2. Lamellar margin of *C. candidissimum.* Bar = 10 µm.

–rather reluctantly– the term **cheilocystidia.** Reijnders & Stalpers (1992) deduce that these 'cheilocystidia' are in fact sterile hyphae of the trama, piercing through the hymenial palisade. They also report that the lamellar margin is sterile, covered by a tuft of tramal hyphae. On the other hand, Senn-Irlet (1990) reports that the margin is never totally sterile and that basidia are always present. In our specimens, we observed that basidia are usually interspersed amongst the 'cheilocystidia', especially in mature specimens, but are significantly shorter. Hence, at a low magnification, the lamellar margin may appear to be sterile if the cheilocystidia are abundant. Some parts of the lamellar edge, particularly those adjacent to the pileal margin, seem indeed to be sterile. This may also be the case in young specimens, in which the lamellar margin seems to be sterile throughout. On the other hand, at the medial parts of the lamellar margin, the cheilocystidia may be less frequent and the basidia may prevail. Reijnders & Stalpers (1992) suppose a tramal origin for the cheilocystidia and provide a convincing photo. According to our observations, the cheilocystidia seem indeed to be tramal projections (Fig. 3e,h) and in some cases basidioles seem to originate from the same tramal hyphae as adjacent cystidia (Fig. 3f-g: arrows).

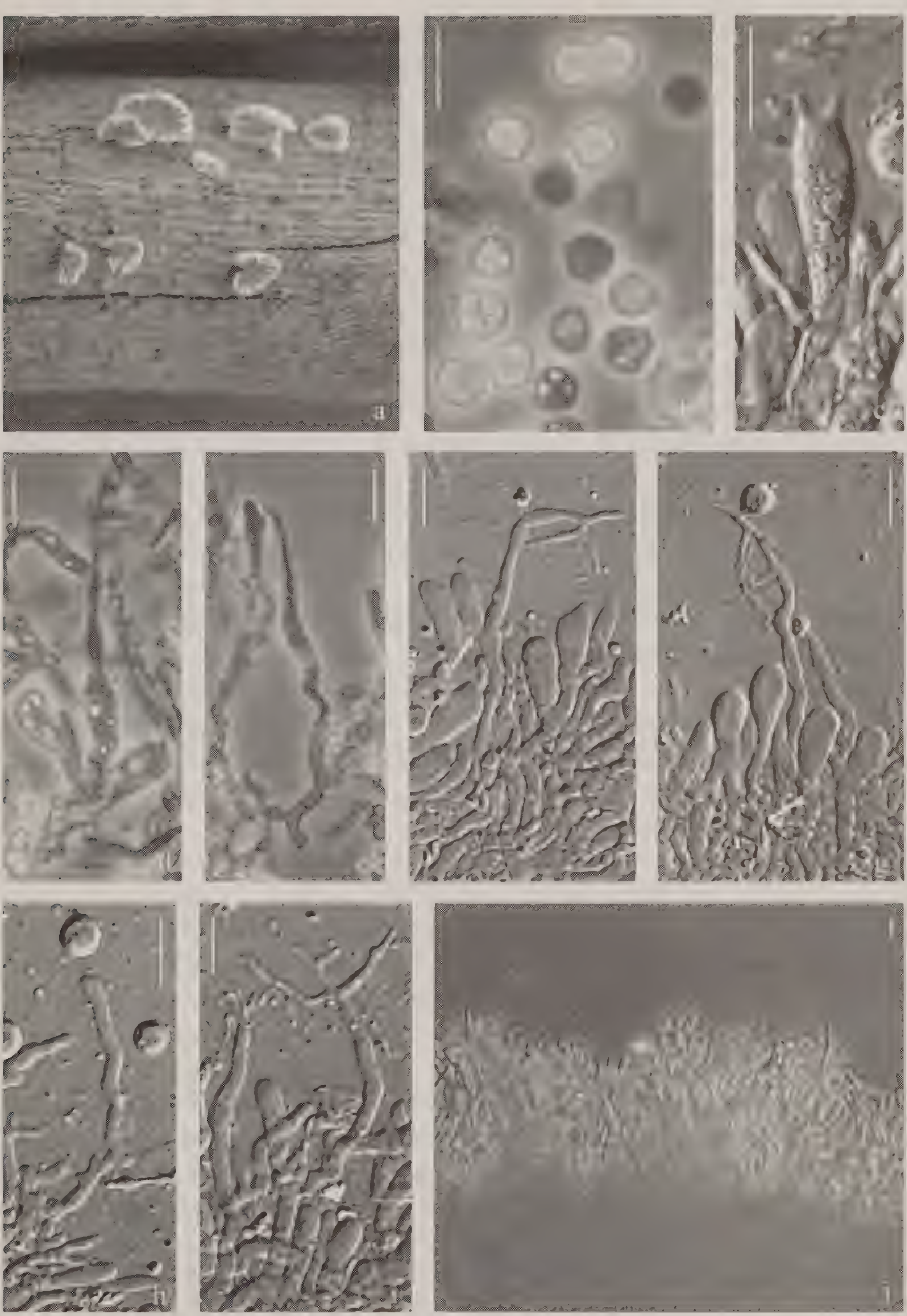

Fig. 3. *Cheimonophyllum candidissimum*: **a.** Dried basidiocarps (ATHU–M 5467). **b.** Basidiospores (ATHU–M 5467). **c.** Basidium with 2 sterigmata (TAA 114978). **d.** Basidiole with secondary growth (ATHU–M 5467). **e-i.** Cheilocystidia (e: ATHU–M 5467; f-i: TAA 114978). **j.** Lamellar margin covered by cheilocystidia (ATHU–M 5467). Bars = 10 µm.

The morphology of the cheilocystidia and their abundance on most lamellae, where they seem to form a protective structure covering the basidia, has led us to speculate that these elements might in fact correspond to **hyphidia,** cells of a supposedly protective nature in aphyllophoroid fungi. The hyphidia may form catahymenia, with buried, scattered basidioles extending though the hyphidial layer only at maturity (Clémençon 1997, 2004). Eriksson & Ryvarden (1973) provide a line drawing of the hymenium of *Aleurodiscus cerussatus,* which shows basidia and **acanthophyses** (termed **acanthohyphidia** by Donk 1964) originating from the same tramal hyphae. This seems to fit well with our observations, as well as with Senn Irlet's report of basidia always being present at the lamellar margin. Petersen & Parmasto (1993) report the presence of hyphidia in *Gloeostereum incarnatum,* a species which, according to molecular data, is closely related to *C. candidissimum* (Moncalvo et al. 2002). Their reference "Hyphidia numerous, undulate, sometimes sparsely branched, 1–2 µm diam." corresponds rather well to the 'cheilocystidia' of *C. candidissimum.* If these species are indeed related, it is quite possible that these cells have a common ancestry and a similar function. To add to the point, Reijnders & Stalpers (1992) note that the hymenophoral trama in *Cheimonophyllum* has a trametoid-type structure, which "is considered a sign of aphyllophoroid relationship".

In some cases, we observed basidioles with secondary growth, giving rise to elements that markedly resemble cystidia (Fig 3d). Such secondary growth of basidia has been noted by Aime (2001) in *Crepidotus,* and considered by her to be induced by humidity.

The distribution of *C. candidissimum* is worldwide, including Europe, North Africa, North and South America, and New Zealand. It seems to be rather common in the Americas. It is listed as common in a Checklist of Columbia Basin Fungi (Miller & Miller 1994). Putzke (2002) reports it from various locations in Brazil. Twelve reports exist from various islands of the Caribbean (Minter et al. 2002) and numerous reports of the species from various locations in U.S.A. and Canada can be found in the Internet. Five collections are reported from New Zealand, where it is rather widely distributed (http://nzfungi.landcareresearch.co.nz/html/mycology.asp). In Europe, Senn-Irlet (1990) noted six examined specimens from Germany, eight from the former USSR (Estonia and Russia), one from Slovakia and one from the Canary Islands (Tenerife). She kindly lent us for examination two of these specimens, as well as three more collected at later dates (two from Switzerland and one from France). She deduced (1990) that the species is rare in Central and Western Europe, and more frequent in East and Northern Europe (noting the presence of exsiccata in herbaria from Norway and Estonia). It is reported as widespread but rare in the UK (Watling & Gregory 1989). It has been listed as Rare in a 1997 red list of Denmark

(Stoltze & Pihl 1998). Four specimens collected from Belgium are kept in the Herbarium of the National Botanic Garden of Belgium (http://www.br.fgov.be). Two cultures isolated from France are available in CBS. Various websites report *C. candidissimum* from several countries of Central and Northern Europe, such as Switzerland, the Netherlands, Norway, Sweden, Finland, Estonia, Latvia and Lithuania. However, the picture is quite different in the countries surrounding the Mediterranean. It is not included in recent checklists from Croatia (Tkalčec & Mešić 2002) and Turkey (Sesli & Denchev 2005). It has not been found in Bulgaria (Gyosheva, pers. com.). We have been unable to find any reports of *C. candidissimum* from other Balkan countries, although we cannot rule out their existence. We have also not found any reports from mainland Spain (the only existing report is from Tenerife), Portugal or Italy. It is not included in a checklist from Sicily (Venturella 1991). It is also not included in recent web-based fungal databases from Ukraine (Minter et al. 2004) and Georgia (Gvritishvili et al. 2007). One sole report exists from Morocco, on *Ilex aquifolium* (Malençon & Bertault 1975, as *Pleurotellus candidissimus*). It has not as yet been recorded from Greece.

C. candidissimum is reported in the literature to grow always on dead branches of deciduous trees, such as *Populus, Alnus, Fraxinus, Corylus, Fagus, Sorbus, Tilia, Salix, Ilex* and *Quercus*. After an extensive search of both printed and web-based literature, we have not encountered any reports of the species on *Platanus*. To our knowledge, this is the first report of *C. candidissimum* on *Platanus orientalis* in Europe, if not worldwide.

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Literature cited

Aime MC. 2001. Biosystematic studies in *Crepidotus* & the *Crepidotaceae* (Basidiomycetes, Agaricales). Ph.D Thesis, Virginia Polytechnic Institute and State University. Blacksburg, Virginia.

Clémençon H. 1997. Anatomie der Hymenomyceten. Teufen.

Clémençon H. 2004. Cytology and Plectology of the *Hymenomycetes.* Bibliotheca Mycologica Vol. 199. J. Cramer, Berlin-Stuttgart.

Donk MA. 1964. A Conspectus of the Families of *Aphyllophorales.* Persoonia 3: 199–324.

Eriksson J, Ryvarden L. 1973. The *Corticiaceae* of North Europe. Vol. 2. Fungiflora, Oslo.

Gvritishvili MN, Hayova VP, Krivomaz TI, Minter DW. 2007. Electronic Distribution Maps of Georgian Fungi. http://www.cybertruffle.org.uk/gruzmaps [website, version 1.10].

ISO 843:1997 (E). Information and documentation – Conversion of Greek characters into Latin characters.

Kirk PM, Ansell AE. 1992. Authors of fungal names. Index of fungi supplement. C.A.B. U.K.

Malençon G, Bertault R. 1975. Flore des Champignons Supérieurs du Maroc. Tome II. Travaux de l' Institut Scientifique Chérifien et de la Faculté des Sciences de Rabat. Série botanique et biologie végétale No 33. Rabat.

Miller OK Jr, Miller HH. 1994. Report on Checklist of Columbia Basin Fungi. Interior Columbia Basin – Ecosystem Management Project. http://www.icbemp.gov/science/miller2.pdf

Minter DW, Hayova VP, Minter TJ, Tykhonenko YY, Andrianova TV, Dudka IO, Heluta VP, Isikov VP, Kondratiuk SY, Krivomaz TI, Kuzub VV, Prydiuk M. 2004. Electronic Distribution Maps of Ukrainian Fungi. http://www.cybertruffle.org.uk/ukramaps/index.htm [website, version 2.00].

Minter DW, Mena Portales J, Rodríguez-Hernández M, Iglesias Brito H, Camino Vilaró M, Mercado Sierra Á. 2002. Electronic Distribution Maps of Caribbean Fungi. http://www.biodiversity.ac.psiweb.com/carimaps. [website version 1.00].

Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jakobsson S, Clémençon H, Miller OK. 2002. One hundred and seventeen clades of euagarics. Mol. Phylogenet. Evol. 23: 357–400.

Petersen RH, Parmasto E. 1993. A redescription of *Gloeostereum incarnatum*. Mycol. Res. 97 (10): 1213–1216.

Putzke J. 2002. Agaricales (Fungos – Basidiomycota) Pleurotóides no Rio Grande do Sul. I – *Anthracophyllum, Aphyllotus, Campanella, Chaetocalathus* e *Cheimonophyllum*. Caderno de Pesquisa Sér. Bio., Santa Cruz do Sol 14 (1): 45–66.

Reijnders AFM, Stalpers JA. 1992. The Development of the Hymenophoral Trama in the *Aphyllophorales* and the *Agaricales*. Studies in Mycology 34. Institute of the Royal Nederlands Academy of Sciences and Lettres.

Segedin BP. 1994. Studies in the *Agaricales* of New Zealand: new records and new species of the genera *Cheimonophyllum, Mniopetalum,* and *Anthracophyllum (Tricholomataceae, Collybieae)*. New Zealand Journal of Botany 32: 61–72.

Senn-Irlet B. 1990. *Cheimonophyllum candidissimum* – ein Portrait. Beiträge zur Kenntnis der Pilze Mitteleuropas VII: 23–28.

Sesli E, Denchev CM. 2005. Checklists of the myxomycetes and macromycetes in Turkey. Mycologica Balcanica 2: 119-160.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4th ed. Koeltz Scientific Books, Koeningstein.

Stoltze M, Pihl S. (red.) 1998. Rødliste 1997 over planter og dyr i Danmark. Miljø- og Energiministeriet, Danmarks Miljøundersøgelser og Skov- og Naturstyrelsen. http://www.sns.dk/1pdf/rodlis.pdf

Tkalčec Z, Mešić A. 2002. Preliminary checklist of *Agaricales* from Croatia. I. Families *Pleurotaceae* and *Tricholomataceae*. Mycotaxon 81: 113–176.

Venturella G. 1991. A check-list of Sicilian fungi. Bocconea 2: 5–221.

Watling R, Gregory N. 1989. *Crepidotaceae, Pleurotaceae* and other pleurotoid agarics. British Fungus Flora 6. Edinburgh.

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Revision of the Herbarium URM I. *Agaricomycetes* from the semi-arid region of Brazil

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Abstract— Forty-one exsiccates of *Agaricomycetes* from the Brazilian semi-arid regions kept at the Herbarium URM were reviewed and the results are commented. The holotypes and isotypes of *Podaxis dilabentis*, *P. deciduus*, and *P. fastigatus* were considered synonyms of *P. pistillaris*. *Scleroderma albidum* and *Lycogalopsis solmsii* are new records for Northeast Brazil.

Key words— *Agaricales, Boletales, Geastrales, Polyporales*, neotropics

Introduction

The Herbarium URM (Department of Mycology, Universidade Federal de Pernambuco) was founded in 1954 and is considered the largest fungal collection in Latin America, housing around 45000 exsiccates which represent 78000 records of all groups of fungi (Maia 2003). This material was mostly incorporated by Augusto Chaves Batista and co-workers, but many donations have also enlarged the collection. Few revisions have been undertaken (Lücking et al. 1999, Cáceres & Lücking 2002, Maia & Gibertoni 2002) and the real nomenclatural situation and the condition of the material is poorly known (Maia et al. 2002).

Financial and technical support to the Herbarium URM has been neglected over the years, despite the personal efforts of the curator to keep the herbarium as a functional collection. Recently, with the recognition of the importance of biological collections for science (Agerer et al. 2000) and the government commitments to the Convention on Biological Diversity, Brazilian funding agencies are starting to stimulate projects for these essential sources of biological information (Ministério da Ciência e Tecnologia 2006).

This work aims to start a series of papers dealing with the revision of macrofungi deposited in URM and intends to confirm the importance of this collection for the studies on mycological diversity and taxonomy.

Material and methods

Basidiomata from the semi-arid region have been collected and deposited in URM since 1944. Their macro- and micro morphological analysis followed the usual procedures for agarics (Singer 1986), polypores (Ryvarden 1991) and gasteroid fungi (Miller & Miller 1988). The names of the species correspond exactly to those of the original herbaria records, and the current nomenclature and systematics follow CABI (www.indexfungorum.org). The words "exsiccatus" and "exsiccata" are abbreviated to "exs."

The semi-arid region is an area of 788.064 km^2 and covers part of nine Brazilian States (Ceará, Piauí, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia, Minas Gerais), the first eight in Northeast Brazil. The vegetation is a mosaic of xerophytes known as "caatingas" (Andrade-Lima 1981). This biome is found only in Brazil and has been poorly investigated by scientists, situation that is recently being reversed by biodiversity projects sponsored by governmental funding agencies.

Results

Agaricales

'***Calvatia cyathiformis*** (Bosc) Morgan'

MATERIAL EXAMINED: BRAZIL. **Pernambuco:** Carnaubeira da Penha, 13.I.2006, *S.M. Silva, S. Silva & F. Wartchow s.n.* (URM 78714).

NOTES: This material was recently collected and described by Wartchow & Silva (2007).

'***Collybia velutipes*** (Curtis) P. Kumm.'

MATERIAL: **missing.**

NOTES: This material was reported by Góes-Neto & Baseia (2006) from the State of Paraíba, but no material was located at herbarium URM, neither under this synonym nor under its current name *Flammulina velutipes* (Curtis) Singer.

'***Lepiota morgani*** Peck'

MATERIAL EXAMINED: BRAZIL. **Bahia**: Santa Inês, Granito Farmer, 13.VIII.1944, *E.B. Wanderley s.n.* (URM 873); **Pernambuco**: Petrolândia, 19.IX.1954, *E. Barros s.n.* (URM 966, discarded on 2002).

Notes: '*L. morgani* Peck' obviously is a miscitation of the name *L. morganii* (Peck) Sacc., a synonym of *Chlorophyllum molybdites* (G. Mey.) Massee. The truncated, dextrinoid and metachromatic basidiospores of URM 873 are microscopic features of the lepiotoid genus *Chlorophyllum* Massee (Vellinga 2003, Vellinga et al. 2003), and the greenish basidiospores (8-12.5 (15.5) x 6.5-8 µm) indicate that this material belongs to *C. molybdites*. It was previously reported from the Atlantic Forest areas of Pernambuco (Pegler & Rayner 1969, Kimbrough et al. 1995), and its occurrence in the semi-arid regions from Bahia reported by Maia & Gibertoni (2002, as '*L. morgani* Peck') is now confirmed.

'***Lycoperdon curtisii*** Berk.'

Material examined: BRAZIL. **Pernambuco:** Caruaru, 13.V.1960, *A.C. Batista s.n.* (URM 47789).

Notes: This exs. corresponds to *Lycogalopsis solmsii* E. Fisch., and was previously reported for South America from Venezuela (Dennis 1970) and the State of Paraná, South Brazil (de Meijer 2006). *L. solmsii* is reported for the first time for Northeast Brazil.

'***Marasmius ruforotula*** Singer'

Material examined: BRAZIL. **Pernambuco**: Caruaru, Serra dos Cavalos, 19. X.1995, *M.H. Alves s.n.* (URM 75616)

Notes: This exs. corresponds to a very small and delicate material obviously belonging to the section *Marasmius*, based on attachment of the lamellae to a very distinct collarium (Singer 1986). A single basidiospore (8 x 4.5 µm) and pileipellis elements of the *Siccus*-type (cells with elongated apical setules, e.g. 15.5 x 7.5 µm in permanent lamina) were observed. More collections of fresh specimens are needed to confirm its occurrence in the Brazilian semi-arid.

'***Marasmius trichorhizus*** Speg.'

Material examined: BRAZIL. **Bahia**: Santo Amaro, 10.VI.1950, *D. Andrade-Lima s.n.* (URM 760)

Notes: The fact that only black rhizomorphs, characteristic of some species of *Marasmius* (Desjardin & Horak 1997), remained of the exs. prevents the confirmation of this species.

'***Omphalia flavida*** (Maub) Rangel' / '***Omphalia flavida*** Maub. & Rangel'

Material examined: BRAZIL. **Pernambuco**: Garanhuns, 19 XI.1951, *R.P. Tenório s.n.* (URM 3440 as '*Omphalia flavida* (Maub) Rangel'); São Caetano, Fazenda Sapucaia, 27.IX.1950 and 26.III.1951, *J.N. Silva s.n.* (URM 101, 102 as '*Omphalia flavida* (Maub) Rangel'); idem, 29.IX.1950, *J.N. Silva s.n.* (URM 426 as '*Omphalia flavida* (Maub) Rangel'); **Ceará**: Serra do Baturité, 25.VII. 1957, *E. Barros s.n.* (URM 17671, 17672, 17673 as '*Omphalia flavida* Maub. & Rangel').

Additional material examined: BRAZIL. **Pernambuco**: Bonito, 11.VIII.1955, J.A.C. *Leão s.n.* (URM 2928, 2929); idem, 25.IX.1955, *A. Menezes s.n.* (URM 2969); idem, 15.X.1955, *A. Menezes s.n.* (URM 2987, 2988); **Ceará**: Serra do Aratanha, 10.IV. 1955, *I.H. Lima s.n.* (URM 2142, 2143); **São Paulo**: Ubatuba, 19.II. 1955, *S.G. Silva s.n.* (URM 1871, 1873).

Notes: *O. flavida* is a synonym of *Mycena citricolor* (Berk. & M.A. Curtis) Sacc. However, the lack of basidiomata in all of the exs. makes dubious the occurrence of *M. citricolor* in Brazil.

'***Podaxis deciduus*** Bat.'

Material examined: BRAZIL. **Pernambuco:** Petrolândia, road Mirim-Petrolândia, 18 IV.1950, A.C. Batista s.n. (IPA 2414 HOLOTYPUS of *P. deciduus*, URM 355 ISOTYPUS).

Notes: See comments under '*Podaxis pistillaris*'.

'***Podaxis dilabentis*** Bat.'

Material examined: BRAZIL. **Pernambuco:** Petrolândia, road Mirim-Petrolândia, 18 IV.1950, A.C. Batista s.n. (IPA 2413 HOLOTYPUS of *P. dilabentis*, URM 756 ISOTYPUS).

Notes: See comments under '*Podaxis pistillaris*'.

'***Podaxis fastigatus*** Bat.'

Material examined: BRAZIL. **Pernambuco:** Petrolândia, road Mirim-Petrolândia, 18 IV.1950, A.C. Batista s.n. (IPA 2415 HOLOTYPUS of *P. fastigatus*).

Notes: See comments under '*Podaxis pistillaris*'.

'***Podaxis pistillaris*** (L.: Pers.) Fr. emend. Morse'

Material examined: BRAZIL. **Pernambuco:** Floresta, Reserva Biológica Serra Negra, IV.2003, *I.G. Baseia s.n.* (URM 77226).

Notes: Baseia & Galvão (2002) suspected that all three species described by Batista (1950) might be synonyms of the cosmopolitan *P. pistillaris*. Morse (1933) affirmed this species to be polymorphic with very variable basidioma and basidiospore size. Comparison of the holotypes at IPA Herbarium (Instituto Pernambucano de Agronomia) supports the conclusion that all three taxa described by Batista (1950) fit Morse's concept of *P. pistillaris*:

Podaxis pistillaris (L.) Fr., Syst. Mycol. 3: 63. 1929.
= *Podaxis dilabentis* Bat., Bol. Agric. Pernambuco 17: 320. 1950.
= *Podaxis deciduus* Bat., Bol. Agric. Pernambuco 17: 321. 1950.
= *Podaxis fastigatus* Bat., Bol. Agric. Pernambuco 17: 320. 1950.

Boletales

'*Pisolithus crassipes* DC.'

Material examined: BRAZIL. **Pernambuco:** Garanhuns, 01.VIII.1946, *A.C. Batista s.n.* (URM 606).

Notes: '*Pisolithus crassipes*' was not found in CABI databases, only *Polysaccum crassipes* DC. Apparently, no new combination has been created since the genus *Polysaccum* F. Desp. & DC. was placed in synonymy with *Pisolithus* Alb. & Schwein. This material was redetermined as *Scleroderma albidum* Pat. & Trab. emend Guzmán, and is reported for the first time from Northeast Brazil.

Corticiales

'*Koleroga noseia* Donk'

Material: BRAZIL. **Bahia:** Alagoinhas, VIII.1935, *col. unknown* (URM 1297, 1298, **both missing**).

Notes: The record appears to be a misspelling of *Koleroga noxia* Donk, which would correspond to *Corticium koleroga* (Cooke) Höhn. However, the exs. were not found, preventing the correct identification of the material.

Geastrales

'*Geaster saccatus* Fr.'

Material examined: BRAZIL. **Pernambuco:** Caruaru, 14.I.1959, *A.C. Batista s.n.* (URM 47819).

Notes: *Geastrum saccatum* Fr. would be the correct orthography for this name; the specimen, however, was redetermined as the pantropical *G. schweinitzii* (Berk. & M.A. Curtis) Zeller.

'*Geaster triplex* Jungh.'

Material examined: BRAZIL. **Pernambuco:** Aliança, 16.VIII.1962, *A.C. Batista s.n.* (URM 47831).

Notes: *Geastrum triplex* Jungh. is the correct orthography for this name. However, two different basidiomata were found in the same exs.: one specimen has a dark and sessile endoperidium with a pruinose surface, indefinite peristome that is lacerate in older fruit bodies, characteristic of *G. fimbriatum* var. *pseudohieronimii* Calonge & M. Mata (Calonge et al. 2005); the other specimen has a developed subiculum and an exoperidium with a very hairy mycelial layer, which are the taxonomic features of *G. hirsutum* Baseia & Calonge, recently described from the Atlantic rainforest area of the State of Pernambuco (Baseia & Calonge 2006).

‘***Geastrum setiferum*** Baseia’

Material examined: BRAZIL. **Pernambuco:** Floresta, Reserva Ecológica de Serra Negra, 28.V.2002, *I.G. Baseia s.n.* (URM 47831).

Notes: The full description and discussion of the species can be found in Baseia & Milanez (2002).

Gloeophyllales

‘***Lenzites cinnamomea*** Fr.’

Material examined: BRAZIL. **Pernambuco:** Garanhuns, 25.V.1965, *A.C. Batista s.n.* (URM 47805).

Notes: *L. cinnamomea* is considered a synonym of the mostly temperate-boreal *L. betulina* (L.) Fr. However, the exs. has a di-trimitic hyphal system and numerous hymenial cystidia that identify this material as the pantropical *Gloeophyllum striatum* (Sw.) Murrill.

Hymenochaetales

‘***Inonotus corrosus*** Murr.’

Material examined: BRAZIL. **Pernambuco:** Surubim, 04.VI.1974, *M.A.Q. Cavalcanti, Cavalcante & Silva s.n.* (URM 72582).

Notes: The sessile basidioma, monomitic hyphal system, and black lines in the context diagnose the material as *Phylloporia chrysites* (Berk.) Ryvarden.

Polyporales

‘***Ganoderma applanata*** **(Pers.) Pat.**’

Material examined: BRAZIL. **Pernambuco:** Pesqueira, 16.IV.1959, *A.C. Batista s.n.* (URM 47803).

Notes: *G. applanatum* (Pers.) Pat. is the correct orthography for this name. The dull, dark brown pileus, brown context and tubes, white hymenial surface diagnose this material as the pantropical *G. australe* (Fr.) Pat. The related species *G. applanatum* has a thinner cuticle, context without black bands and shorter basidiospores, and is restricted to the temperate zone (Ji-Ding 1989, Moncalvo & Ryvarden 1997, Ryvarden 2004).

‘***Ganoderma lucidum*** Leys’

Material examined: BRAZIL. **Pernambuco:** Caruaru, 28.V.1955, *A.C. Batista s.n.* (URM 2334).

Notes: *G. lucidum* (Curtis) P. Karst. is the correct citation for this name. Although the material was sterile, it was redetermined as the neotropical *G. stipitatum* (Murrill) Murrill based on the amyloid, regular cells of the cuticle and the black lines in both the context of the pileus and stipe. Molecular data (Moncalvo et al. 1995, Moncalvo & Ryvarden 1997) suggest that *G. lucidum* may be restricted to Europe.

'***Favolus maxonii*** Murr.'

MATERIAL EXAMINED: BRAZIL. **Ceará:** Juazeiro, 22 V.1957, *C. Torrend s.n.* (URM 7425).

NOTES: *F. maxonii* (Murrill) Sacc. & Trotter is the correct citation for this name, which corresponds to the pantropical *F. tenuiculus* P. Beauv. This is the first record of the species for the State of Ceará.

'***Fomes squarrosus*** Lloyd'

MATERIAL EXAMINED: BRAZIL. **Piauí:** Oeiras, 16.VIII.1948, *A.C. Batista s.n.* (URM 681).

NOTES: The exs. is in poor condition, and the material was tentatively redetermined as the tropical, widespread *F. fasciatus* (Sw.) Cooke. This is the first record of the species for the State of Piauí.

'***Polystictus cinnabarinus*** (Jacq.) Fr.'

MATERIAL EXAMINED: BRAZIL. **Paraíba:** Areia, 29.X.1946, *A.C. Batista s.n.* (URM 2334).

NOTES: *P. cinnabarinus* (Jacq.) Cooke is the correct citation for this name. This specimen was re-identified as the pantropical, widespread *Pycnoporus sanguineus* (L.) Murrill.

'***Polystictus membranaceus***'

MATERIAL EXAMINED: BRAZIL. **Bahia:** Santo Amaro, 23.V.1957, *A.C. Batista s.n.* (URM 7450).

NOTES: *P. membranaceus* (Sw.) Fr. is the full citation for this name. Although the basidiospores were mostly collapsed, the trimitic hyphal system and the black, permanent reaction to KOH diagnose this specimen as the pantropical and common *Coriolopsis floccosa* (Jungh.) Ryvarden.

'***Polystictus pallido-mollis*** Lloyd'

MATERIAL EXAMINED: BRAZIL. **Bahia:** Santo Amaro, 5.XII.1957, *A.C. Batista s.n.* (URM 9731).

NOTES: This name was not found in CABI or CBS (www.cbs.knaw.nl) databases, and is not listed in Stevenson (1933) or Stevenson & Cash (1936). The grayish colour, the dimitic hyphal system and the hymenial cystidia diagnose the exs. as *Trichaptum biforme* (Fr.) Ryvarden.

'***Polystictus pinsitus*** Fr.'

Material examined: BRAZIL. **Bahia:** Conde, 8.II.1955, *A.C. Batista s.n.* (URM 1242).

Notes: *P. pinsitus* (Fr.) Cooke is the correct citation for this name. This specimen was re-identified as *Coriolopsis floccosa.*

'***Polyporus cinnabarinus*** Jacq. & Fr.'

Material: BRAZIL. **Bahia:** Conde, 16.VII.1957, *A.C. Batista s.n.* (URM 11449, missing)

Notes: *P. cinnabarinus* (Jacq.) Fr. is the correct citation for this name. However, the exs. was not found.

'***Polyporus megaloporus*** Mont.'

Material examined: BRAZIL. **Bahia:** Mundo Novo, 13.VI.1957, *C. Torrend s.n.* (URM 7355).

Notes: *P. megaloporus* Mont. was described in 1854 and is a nom. illegit. (non *Polyporus megaloporus* Pers. 1825). This material was in poor conditions and was discarded on 08.XI.2000.

'***Trametes rigida*** Berk. & Mont.'

Material examined: BRAZIL. **Bahia:** Caetité, 4.VI.1957, *L.G. Dialer s.n.* (URM 7697).

Notes: The material was redetermined as *Coriolopsis floccosa.*

Russulales

'***Stereum glabrensis*** Berk. & M.A. Curtis'

Material examined: BRAZIL. **Pernambuco:** Triunfo, 25.V.1965, *A.C. Batista s.n.* (URM 47780).

Notes: This name appears to be an error for *S. glabrescens* Berk. & M.A. Curtis, which is the basionym of *Podoscypha glabrescens* (Berk. & M.A. Curtis) Boidin. However, the macro-morphological characters suggest this material represents *S. ostrea* (Blume & T. Nees) Fr.

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Literature cited

Agerer R, Ammirati J, Baroni TJ, Blanz P, Courtecuisse R, Desjardin DE, Gams W, Hallenberg N, Halling R, Hawksworth DL, Horak E, Korf RP, Mueller GM, Oberwinkler F, Rambold G, Summerbell RC, Triebel D, Watling R. 2000. Open letter to the scientific community of mycologists: Provide voucher specimens. Mycotaxon 76: 489-493.

Andrade-Lima D. 1981. The caatingas dominum. Rev. Bras. Bot. 4: 149-163.

Baseia IG, Calonge FD. 2006. *Geastrum hirsutum*: a new earthstar fungus with a hairy exoperidium. Mycotaxon 95: 301-304.

Baseia IG, Galvão TCO. 2002. Some interesting *Gasteromycetes* (*Basidiomycota*) in dry areas of the Northeastern Brazil. Acta Bot. Bras. 16: 1-8.

Baseia IG, Milanez AI. 2002. *Geastrum setiferum* (*Gasteromycetes*): a new species with a setose endoperidium. Mycotaxon 84: 135-139.

Batista AC. 1950. Três novos *Podaxis* de Pernambuco. Bol. Secr. Agric. Recife 17: 320-324.

Calonge FD, Mata M, Carranza J. 2005. Contribución al catálogo de los *Gasteromycetes* (*Basidiomycotina*, *Fungi*) de Costa Rica. An. Jard. Bot. Madrid 62: 23-45.

Cáceres MES, Lücking R. 2002. Liquens foliícolas registrados em Pernambuco. In: M Tabarelli & JMC Silva (orgs.). Diagnóstico da Biodiversidade de Pernambuco. Vol. 1. Editora Massangana, Recife.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Add. Ser. 3 : 1-512.

Desjardin DE, Horak E. 1997. *Marasmius* and *Gloiocephala* in the South Pacific Region: Papua New Guinea, New Caledonia, and New Zealand taxa. Biblioth. Mycol. 168: 1-152.

Góes-Neto A, Baseia IG. 2006. Filo *Basidiomycota*. In: Gusmão LFP, Maia LC. Diversidade e Caracterização dos Fungos do Semi-Árido Brasileiro. Associação Plantas do Nordeste.

Ji-Ding Z. 1989. The *Ganodermataceae* in China. Bibliotheca Mycologica 132, J. Cramer, Berlin.

Kimbrough JW, Alves MH. & Maia LC. 1994/1995. *Basidiomycetes* saprófitos em troncos vivos e em folhedos de "sombreiro" (*Clitoria fairchildiana* [Benth.] Howard). Biol. Bras. 6: 51-56.

Lücking R, Cáceres MES, Maia LC. 1999. Revisão nomenclatural e taxonômica de liquens foliícolas e respectivos fungos liquenícolas registrados para o Estado de Pernambuco, Brasil, por Batista e colaboradores. Acta Bot. Bras. 13: 115-128.

Maia LC. 2003. Coleções de fungos nos herbários brasileiros: estudo preliminar. In: AL Peixoto (org.) Coleções Biológicas de Apoio ao Inventário, Uso Sustentável e Conservação da Biodiversidade. Instituto de Pesquisas Jardim Botânico do Rio de Janeiro, Rio de Janeiro.

Maia LC, Gibertoni TB. 2002. Fungos registrados no semi-árido nordestino. In: Sampaio EVSB, Giulietti AM, Virgínio J, Gamarra-Rojas CFL (ed.). Vegetação e Flora da Caatinga. Recife, Associação Plantas do Nordeste/APNE e Centro Nordestino de Informações sobre Plantas/CNIP.

Maia LC, Yano-Melo AM, Cavalcanti MAQ. 2002. Diversidade de Fungos no Estado de Pernambuco. In: Tabarelli M, Silva JMC. (ed.). Diagnóstico da Biodiversidade de Pernambuco. Ed. Massangana, Recife.

de Meijer AAR. 2006. A preliminary list of the macromycetes from the Brazilian State of Paraná. Bol. Mus. Bot. Municipal 68: 1-54.

Miller-Junior OK, Miller HH. 1988. *Gasteromycetes*: Morphology and Developmental Features. Ed. Mad River, Eureka.

Ministério da Ciência e Tecnologia. 2006. Diretrizes e estratégias para modernização de coleções biológicas e a consolidação de sistemas integrados de informação sobre biodiversidade. Centro de Gestão e Estudos estatégicos – MCT, Brasília.

Moncalvo JM, Ryvarden L. 1997. A nomenclatural study of the *Ganodermataceae* Donk. Synopsis Fungorum 11, Fungiflora. Oslo.

Moncalvo JM, Wang HF, Hseu RS. 1995. Gene phylogeny of the *Ganoderma lucidum* complex. Comparison with traditional taxonomic characters. Mycological Research 99: 1489-1499.

Morse EE. 1933. A study of the genus *Podaxis*. Mycologia 25: 1-33.

Pegler DN, Rayner RW. 1969. A contribution of the agaric flora of Kenya. Kew Bull. 23: 347-412.

Ryvarden L. 1991. Genera of Polypores. Nomenclature and Taxonomy. Synopsis Fungorum 5, Fungiflora, Oslo

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th Ed. Koeltz Scientific Books, Stuttgart.

Stevenson JA. 1933. General index to the mycological writings of C.G. Lloyd 1898-1925. Bull. Lloyd Libr. Bot. 32: 1-64

Stevenson JA, Cash EK. 1936. The new fungus names proposed by C.G. Lloyd. Bull. Lloyd Libr. Bot. 35: 1-209.

Vellinga EC. 2003. *Chlorophyllum* and *Macrolepiota* (*Agaricaceae*) in Australia. Aust. Syst. Bot. 16: 361-370.

Vellinga EC, de Kok RPJ, Bruns TD. 2003. Phylogeny and taxonomy of *Macrolepiota* (*Agaricaceae*). Mycologia 95: 442-456.

Wartchow F, Silva SM. 2007. Primeira ocorrência de *Calvatia cyathiformis* (*Basidiomycota*) em caatinga, Estado de Pernambuco, Brasil. Sitientibus Ser. Ciênc. Biol. 7: 176-177.

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Santa Catarina Island mangroves 2 – First report of *Cytospora rhizophorae* from Brazil

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Abstract — A survey on wood-decay fungi from mangroves in Santa Catarina Island (Southern Brazil) resulted in numerous species of fungi. One of them, *Cytospora rhizophorae*, is the first record in Brazil. *Laguncularia racemosa* has been recorded as its host for the first time.

Key words — mycodiversity, anamorphic fungi, neotropical

Introduction

Cytospora rhizophorae (anamorphic fungi) was described by Kohlmeyer & Kohlmeyer (1971) on *Rhizophora mangle* L. in mangroves from Guatemala (holotype). Additional specimens examined by the authors were collected in mangroves of Liberia (on *Rhizophora racemosa* G.Mey.), Hawaii (USA), Bahamas Island, Florida (USA) and Mexico. Further records were done from Puerto Rico, Sierra Leona, Malaysia, Australia and Papua-New Guinea, (Shaw 1989, Tattar et al. 1994), India (Maria & Sridhar 2002) and Martinique (Kohlmeyer 1981) also in mangrove areas. Both *R. mangle* and *R. racemosa* trees are distributed along Brazilian northern coastal zones. The southern Brazil mangroves' typical trees are: *R. mangle*, *Laguncularia racemosa* (L.) C.F.Gaertn. and *Avicennia schaueriana* Stapf & Leechm. ex Moldenke (Souza-Sobrinho et al. 1969). Even though *R. mangle* and *R. racemosa* are found in Brazil, *C. rhizophorae* has never been reported in Brazil until now.

In the original article Kohlmeyer & Kohlmeyer (1971) presented evidences about parasitism of this fungus. They observed the dying-back of young plants and seedlings and the destruction of aerial roots and proproots of *Rhizophora*. This opinion was followed by further authors (Tattar et al. 1994, Wier et al.

1996, 2000; Tattar & Wier 2002) who considered this species as a pathogen from *R. mangle*.

Initially, this species was regarded as host-specific in *R. mangle* and *R. racemosa*, however it was also gathered on *Rhizophora apiculata* Blume, *Rhizophora stylosa* Griff., *Sonneratia caseolaris* (L.) Engl. and *Bambusa vulgaris* Schrad. (Kohlmeyer & Volkmann-Kohlmeyer 1989, Shaw 1989).

According to Kohlmeyer & Kohlmeyer (1971) *C. rhizophorae* can be considered a halotolerant and facultative marine species, it can be found in immersed and submerged parts of the host, next to marine ascomycetes and wood-boring animals.

The main objective of this article is to expand *C. rhizophorae* distribution.

Materials and methods

Collections were performed between August/2005 and July/2006 in four mangroves (Rio Tavares, Itacorubi, Saco Grande and Ratones) on Santa Catarina Island (27°35' S and 48°32' W), in Southern Brazil. The typical mangrove trees from these areas are *A. schaueriana* (black mangrove), *L. racemosa* (white mangrove) and *R. mangle* (red mangrove).

The specimen examinations (macro- and microscopic) and identifications were carried out by traditional methods in the Laboratory of Mycology, Department of Botany, UFSC. Vouchers are deposited on Herbarium FLOR (Holmgren et al 1990).

Results

Seven specimens of *C. rhizophorae* were collected on mangroves from Santa Catarina Island. Four of them were on dead trunks and branches of *R. mangle* (Rio Tavares and Itacorubi), and three were on *L. racemosa* (Saco Grande).

Despite the fact that *A. schaueriana* is the dominant tree in Santa Catarina Island mangroves, no specimens of *C. rhizophorae* were collected on it.

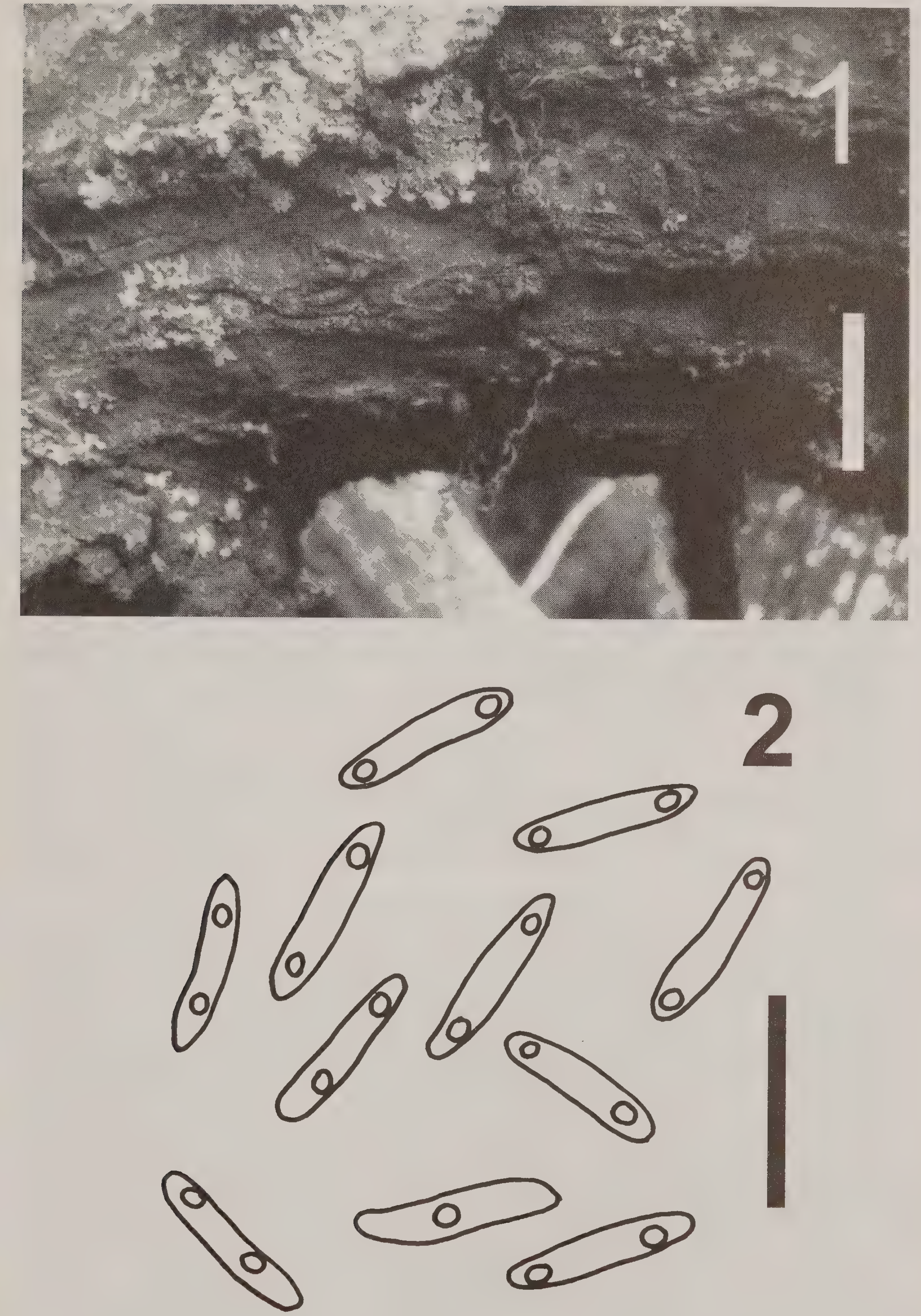
Cytospora rhizophorae Kohlm. & E.Kohlm., Mycologia 63(4): 847, 1971.

FIGURES 1-2

Description in Kohlmeyer & Kohlmeyer (1971: 847-848).

DISTRIBUTION — pantropical; Australia, Bahamas Island, Bermuda, Brazil (Santa Catarina Island, first record), Guatemala, India, Liberia, Malaysia, Martinique, México, Papua-New Guinea, Puerto Rico, Sierra Leona and U.S.A. (Florida, Hawaii).

SPECIMENS EXAMINED — BRAZIL. SANTA CATARINA: **Florianópolis**. Ilha de Santa Catarina, Manguezal do Itacorubi, on *Rhizophora mangle*, col. Trierveiler-Pereira & Marcon-Baltazar *s/n*, 26.X.2005 (*FLOR 31899*); Ilha de Santa Catarina, Manguezal do Rio Tavares, on *R. mangle*, col. Trierveiler-Pereira & Mozerle *208*, 27.IV.2006 (*FLOR*



Figures 1-2. *Cytospora rhizophorae*.
1: cirri (scale bar = 2.0 cm), 2: spores (scale bar = 5 µm).

31900); Ilha de Santa Catarina., Manguezal do Saco Grande, on *Laguncularia racemosa*, col. Trierveiler-Pereira & Marcon-Baltazar *s/n*, 28.V.2006 (*FLOR 31901*); Ilha de Santa Catarina, Manguezal do Saco Grande, on *L. racemosa*, col. Marcon-Baltazar & Santos *241*, 25.VI.2006 (*FLOR 31902*); Ilha de Santa Catarina, Manguezal do Saco Grande, on *L. racemosa*, col. Marcon-Baltazar & Santos *252*, 25.VI.2006 (*FLOR 31903*); Ilha de Santa Catarina, Manguezal do Rio Tavares, on *R. mangle*, col. Trierveiler-Pereira & Marcon-Baltazar *276*, 22.VII.2006 (*FLOR 31904*); Ilha de Santa Catarina, Manguezal do Rio Tavares, on *R. mangle*, col. Trierveiler-Pereira, Maccarini & Assis *306*, 05.VIII.2006 (*FLOR 31905*).

COMMENTS — The species can be easily recognized in the field by its bright orange cirri, which can be as long as 5.0 cm. Conidia measures (3,5-5,5 x 1-1,5 µm) are similar to those described by Kohlmeyer & Kohlmeyer (1971). *C. rhizophorae* has been recorded for the first time in Brazilian mangroves. *L. racemosa* is the first record as a host for *C. rhizophorae*.

Acknowledgments

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Literature cited

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Part I. The herbaria of the world, 8th ed. New York botanical Garden, Bronx.

Kohlmeyer J, Kohlmeyer E. 1971. Marine fungi from tropical America and Africa. Mycologia 63: 831-861.

Kohlmeyer J. 1981. Marine fungi from Martinique. Canadian Journal of Botany 59(7): 1314-1321.

Kohlmeyer J, Volkmann-Kohlmeyer B. 1989. Hawaiian marine fungi, including two new genera of *Ascomycotina*. Mycological Research 92(4): 410-421.

Maria GL, Sridhar KR. 2002. Richness and diversity of filamentous fungi on woody litter of mangroves along the west coast of India. Current Science 83(12): 1573-1580.

Shaw DE. 1989. Spore extrusion of mangrove fungi in Papua New Guinea and Australia. Mycologist 3: 118-120.

Souza-Sobrinho RJ, Bresolin A, Klein RM. 1969. Os manguezais da Ilha de Santa Catarina. Insula 2:1-21.

Tattar TA, Klekowski EJ, Stern AI. 1994. Dieback and mortality in red mangrove, *Rhizophora mangle* L., in southwest Puerto Rico. Arboricultural Journal 18: 419-429.

Tattar TA, Wier AM. 2002. Proposed etiology of *Cytospora rhizophorae* canker of *Rhizophora mangle* in southwestern Puerto Rico. Caribbean Journal of Science 38: 156-158.

Wier AM, Schnitzler MA, Tattar TA, Klekowski Jr EJ, Stern AI. 1996. Wound periderm development in red mangrove, *Rhizophora mangle* L. International Journal of Plant Science 157: 63-70.

Wier AM, Tattar TA, Klekowski Jr EJ. 2000. Disease of red mangrove (*Rhizophora mangle*) in southwestern Puerto Rico caused by *Cytospora rhizophorae*. Biotropica 32: 299-306.

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Two new dictyosporous hyphomycetes on *Pandanaceae*

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Abstract—*Berkleasmium pandani*, found on dead leaves of *Pandanus* sp. in Malaysia, and *Dictyosporium freycinetiae*, found on dead leaves of *Freycinetia banksii* in New Zealand, are illustrated and described as new species and compared with related taxa.

Key words—anamorphic fungi, deuteromycetes, *Oncopodium*, taxonomy

Introduction

During investigations of saprobic microfungi that occur on members of the *Pandanaceae* (e.g., Whitton et al. 2003), two dictyosporous species were found and determined to be undescribed species of *Berkleasmium* and *Dictyosporium*. The *Berkleasmium* was found in Malaysia on decaying leaves of *Pandanus* sp., while the *Dictyosporium* was found on decaying leaves of *Freycinetia banksii* in New Zealand. The new species of *Berkleasmium* was previously referred to as an *Oncopodium*-like species (McKenzie & Hyde 1997).

Materials and methods

Dead leaves of *Pandanus* sp. and of *Freycinetia banksii* were collected from forested areas in Malaysia and New Zealand, respectively. The *Freycinetia* leaves were collected during the running of a 24-hour BioBlitz (McKenzie et al. 2007). The leaves were incubated under humid conditions and periodically examined for sporulating microfungi. Fungal fruiting structures were removed, mounted in lactophenol or water, and examined by light microscopy. Measurements were made on material mounted in lactophenol. Dried herbarium specimens of the two new fungi were prepared and deposited in the New Zealand Fungal Herbarium (Herb. PDD). Each species is known only from the holotype.

Taxonomy

Berkleasmium: The genus *Berkleasmium* Zobel is characterised by the formation of conidia in superficial, circular, punctiform sporodochia that are typically dark and shiny when viewed in situ. The conidia are muriform, often with numerous cells, generally smooth, often slightly constricted at the septa, pale to dark brown, and ellipsoidal to almost globose, often with a portion of the conidiogenous cell attached, or with one or more hyaline subtending cells (Moore 1959, Ellis 1971, Zhao & Zhang 2004). Bussaban et al. (2001) provided a synopsis of the genus and a key to the species of *Berkleasmium*. Since then, additional species have been described by Somrithipol & Jones (2003), Taylor & Hyde (2003), Zhao & Zhang (2004), and Pinnoi et al. (2007). Currently there are 29 species of *Berkleasmium*, distinguished primarily on conidiophore shape and pigmentation, and conidial morphology and size (Moore 1959, Ellis 1971, Matsushima 1981, 1983, 1987, Holubová-Jechová 1987). A specimen collected on *Pandanus* sp. in Malaysia is distinct from all other known species, and is described here.

Berkleasmium pandani McKenzie, **sp. nov.** **Figs 1–3**

MycoBank: MB 511285

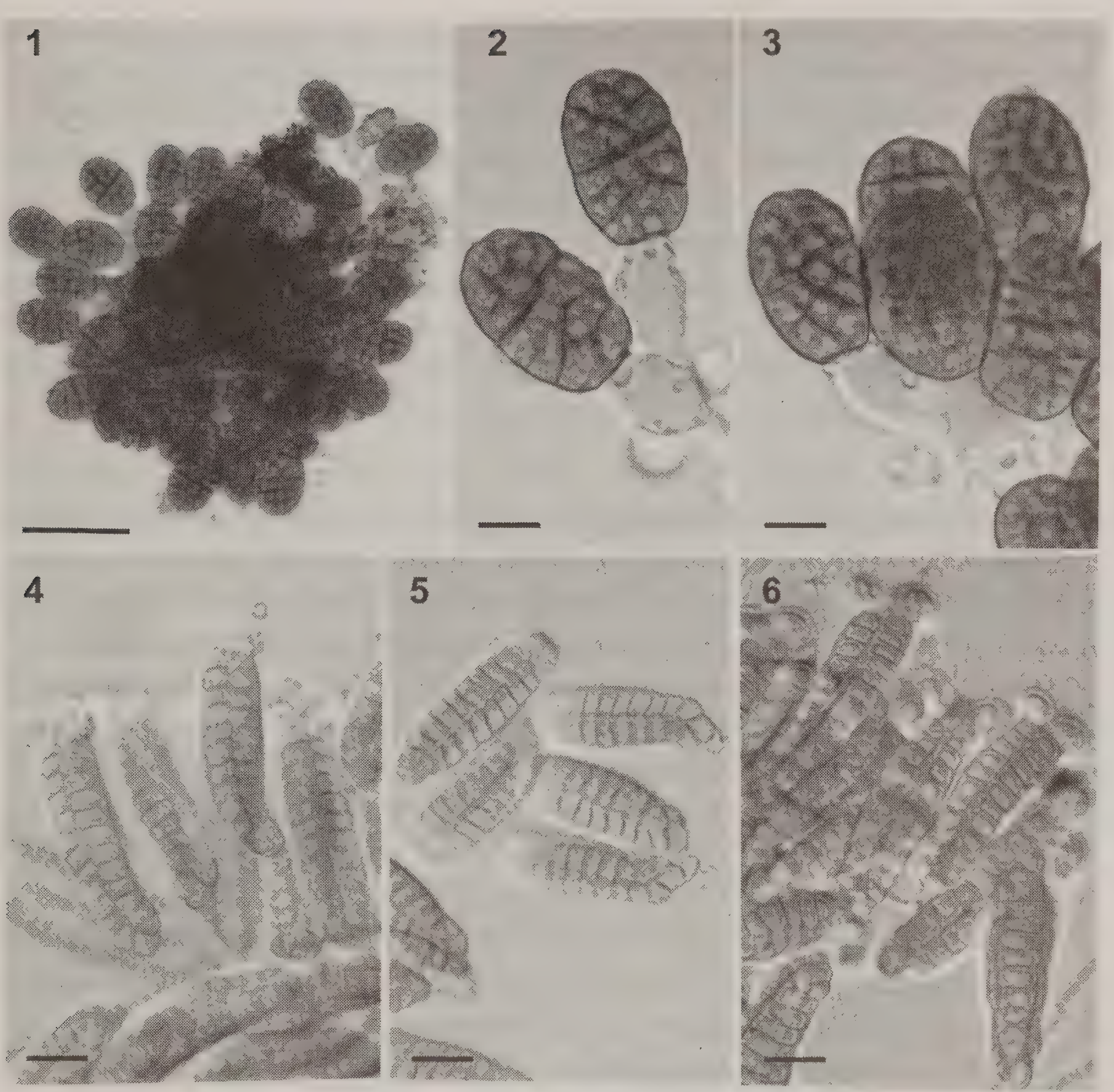
Conidiomata sporodochia, punctiformis, sparsa, pulvinata, atro-brunnea. Mycelium ex hyphis plerumque in substrato immersum, ramosis, septatis, laevibus, luteis vel pallide brunneis, tenuitunicatis, 2–3 μm crassis compositum. Conidiophora macronematosa, mononematosa, aseptata, hyalinae, tenuitunicata, laevia. Cellulae conidiogenae holoblasticae, determinatae, clavatae, usque ad 45 μm longa, 10–19 μm lata ad maxime crassorum posito, 2–4 μm lata ad basim. Conidia solitaria, sicca, acrogena, brunnea, laevia, ovalia vel oblonga-ellipsoidea, muriformia, septatis, constricta vel non constricta, 27–34 × 18–22.5 μm, plerumque in maturitate persistentia in loco conidiogeno.

Etymology: named after the host substrate, *Pandanus* sp.

Holotypus: MALAYSIA, Genting Highlands, Ganung Buah, in foliis mortuis pandanacearum *Pandanus* sp. (*Pandanaceae*), 18 August 1992, E.H.C. McKenzie (PDD 60532).

Colonies in the form of punctiform sporodochial conidiomata, scattered, pulvinate, dark brown, shiny or glistening, more or less circular. Mycelium mainly immersed in the substratum. Hyphae branched, septate, smooth, yellowish to pale brown, thin-walled, 2–3 μm diam. Conidiophores reduced to conidiogenous cell, differentiated, single, aseptate, hyaline, thin-walled, smooth. Conidiogenous cells holoblastic, determinate, clavate, up to 45 μm long consisting of a basal portion up to 21 μm long, 2–4 μm wide, and a swollen apical portion 16–26 μm long, 10–19 μm wide. Conidia solitary, dry, acrogenous, brown, smooth, oval to oblong-ellipsoidal, muriform with transverse, longitudinal, and oblique septa, sometimes slightly constricted at the median septa and other septa, 27–34 × 18–22.5 μm (mean = 30.6 × 19.9 μm, n = 30), conidiogenous cell usually remaining attached to base of conidium at maturity.

Comments: The conidia of *Berkleasmium pandani* are similar to those of *B. corticola* (P. Karst.) R.T. Moore, *B. crunisia* Pinnoi, *B. inflatum* Hol.-Jech., *B. moriforme* (Peck) R.T. Moore, *B. nigroapicale* Bussaban et al., *B. sinense*



Figs 1–3. Conidia and conidiogenous cells of *Berkleasmium pandani* (from holotype). **Figs 4–6.** Conidia of *Dictyosporium freycinetiae* (from holotype). Specimens mounted in hydrous lactophenol, except Fig. 6, which is in water. Scale bars: 1 = 50 µm; 2–6 = 10 µm.

Joanne E. Taylor et al., and *B. taishanense* G.Z. Zhao & T.Y. Zhang, all of which have subtending cell(s), or when detached carry away part of the swollen conidiogenous cell. *Berkleasmium typhae* Somrith. & E.B.G. Jones has an inflated conidiogenous cell but this is not usually detached along with the conidium (Somrithipol & Jones 2003). The conidia of *B. crunisia*, *B. inflatum*, and *B. sinense* are larger than those of *B. pandani* or of the other species with subtending cells or swollen conidiogenous cells. In conidial size *B. pandani* most closely matches *B. moriforme* and *B. taishanense*, but these three species can be separated by differences in conidial shape and septation.

The specimen of *Berkleasmium pandani* was previously referred to as *Oncopodium*-like (McKenzie & Hyde 1997). However, the genus *Oncopodium* differs from *Berkleasmium* in that the conidia of *Oncopodium* species are horizontally oriented, so that the conidium is wider than long; the conidium is attached on its long axis to the conidiogenous cell (Castañeda Ruíz et al. 1997). *Oncopodium* species also produce sporodochial conidiomata and a swollen conidiogenous cell that remains attached to the conidium in a similar manner to some species of *Berkleasmium*. The conidia of *Dictyosporium gauntii* Bhat & B. Sutton also secede with a hyaline, swollen conidiogenous cell at the base (Goh et al. 1999). However, the conidia of *D. gauntii* are larger than those of *B. pandani* measuring 40–50 × 18–25 µm and consist of 4–6 tightly compacted, incurved rows of cells.

Dictyosporium: Superficially, the genus *Dictyosporium* Corda resembles *Berkleasmium*. Colonies of *Dictyosporium* are also often in the form of compact sporodochial conidiomata, but the genus is characterised by having poorly differentiated conidiophores and conidia with ordered rows of cells arranged either flattened in one plane (complanate) or not flattened. The number of rows of cells is usually constant within a species. Goh et al. (1999) revised the genus *Dictyosporium* and provided a key to the species. Since then six additional species have been described: *D. triramosum* Aramb. et al. (Arambarri et al. 2001), *D. musae* Photita (Photita et al. 2002), *D. taishanensis* G.Z. Zhao & T.Y. Zhang (Zhao & Zhang, 2003), and *D. tetrasporum* L. Cai & K.D. Hyde (Cai & Hyde 2007). Cai et al. (2003) described *D. lakefuxianensis* L. Cai et al. and *D. yunnanensis* L. Cai et al. and provided an updated key to the genus. A specimen collected recently in New Zealand on dead leaves of *Freycinetia banksii* is distinct from any known species of *Dictyosporium* and is described here.

Dictyosporium freycinetiae McKenzie, **sp. nov.** **Figs 4–6**

MycoBank: MB 511286

Conidiomata sporodochia, punctiformis, sparsa, pulvinata, cinerascens. Mycelium ex hyphis in substrato immersum. Conidiophora micronematosa, mononematosa, aseptata, subhyalinae, tenuitunicata, laevia. Cellulae conidiogenae holoblasticae, determinatae, cylindrica, usque ad 7 µm longa, 2–3.5 µm lata. Conidia solitaria, sicca, acrogena, straminea, laevia, cylindrica, non-complanata, recta vel flexuosa, in 26–37 cellulis 3-serietibus composita, constricta, (27–)31–43 × 10–12 µm; cellula apicalis serietibus cum appendicibus subglobosa, hyalinis, praedita.

Etymology: named after the host substrate, *Freycinetia banksii*.

Holotypus: NEW ZEALAND, Auckland, Henderson, Shona Reserve, in foliis mortuis pandanacearum *Freycinetia banksii* A. Cunn. (*Pandanaceae*), 26 March 2006, E.H.C. McKenzie (PDD 88237).

COLONIES in the form of punctiform sporodochial conidiomata, scattered, pulvinate, greyish, more or less circular or oval. MYCELIUM immersed in the substratum. CONIDIOPHORES reduced to conidiogenous cell, poorly differentiated, single, aseptate, subhyaline, thin-walled, smooth.

Conidiogenous cells holoblastic, determinate, cylindrical, up to 7 µm long, 2–3.5 µm wide. Conidia solitary, dry, acrogenous, straw coloured, smooth, cylindrical, not complanate, straight or slightly curved, consisting of 26–37 cells arranged in 3 closely appressed rows arising from a basal cell 4–5.5 µm wide, basal cell typically rounded or diamond-shaped but sometimes truncate, often with a small, persistent portion of the conidiogenous cell, each row of more or less equal length, containing 9–13 cells, slightly constricted at septa, slightly thickened walls and septa, no pores visible on septa, (27–)31–43 × 10–12 µm (mean = 34.4 × 10.8 µm, n = 45), apical cell of each row becoming a swollen, outwardly curved, subglobose, hyaline appendage, 4–7.5 µm long × 6–7 µm wide.

Comments: There are nine species of *Dictyosporium* that have conidia with variously developed appendages. Of these, only the conidia of *D. manglietiae* Kodsueb & McKenzie (Kodsueb et al. 2006) consistently comprise 3 rows of cells. However, the conidia of *D. manglietiae* are complanate with only 16–19 cells, and the relatively long (12–32 µm) single appendage arises from a basal cell. In *D. freycinetiae* the appendage appears to consist of a swollen, hyaline, apical cell. In some conidia the cell has not become swollen and in these cases the apical cell of each row of cells is hyaline rather than the straw colour of the other cells.

Acknowledgments

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Literature cited

Arambarri AM, Cabello MN, Cazau MC. 2001. *Dictyosporium triramosum*, a new hyphomycete from Argentina. Mycotaxon 78: 185–189.

Bussaban B, Lumyong S, Lumyong P, McKenzie EHC, Hyde KD. 2001. A synopsis of the genus *Berkleasmium* with two new species and new records of *Canalisporium caribense* from *Zingiberaceae* in Thailand. Fungal Diversity 8: 73–85.

Cai L, Hyde KD. 2007. Anamorphic fungi from freshwater habitats in China: *Dictyosporium tetrasporum* and *Exserticlava yunnanensis* spp. nov., and two new records for *Pseudofuscophialis lignicola* and *Pseudobotrytis terrestris*. Mycoscience 48: 290–296.

Cai L, Zhang K, McKenzie EHC, Lumyong S, Hyde KD. 2003. New species of *Canalisporium* and *Dictyosporium* from China and a note on the differences between these genera. Cryptogamie, Mycologie 24: 3–11.

Castañeda Ruíz RF, Guarro J, Cano J. 1997. Notes on conidial fungi. XI. Two new species of *Cheiromoniliophora* and *Oncopodium*. Mycotaxon 61: 319–326.

Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, U.K. 608 pp.

Goh T-K, Hyde KD, Ho WH, Yanna. 1999. A revision of the genus *Dictyosporium*, with descriptions of three new species. Fungal Diversity 2: 65–100.

Holubová-Jechová V. 1987. Studies on hyphomycetes from Cuba V. Six new species of dematiaceous hyphomycetes from Havana Province. Česká Mykologie 41: 29–36.

Kodsueb R, Lumyong S, Hyde KD, Lumyong P, McKenzie EHC. 2006. *Acrodictys micheliae* and *Dictyosporium manglietiae*, two new anamorphic fungi from woody litter of *Magnoliaceae* in northern Thailand. Cryptogamie, Mycologie 27: 111–119.

Matsushima T. 1981. Matsushima Mycological Memoirs 2. Published by the author, Kobe, Japan. 68 pp.

Matsushima T. 1983. Matsushima Mycological Memoirs 3. Published by the author, Kobe, Japan. 89 pp.

Matsushima T. 1987. Matsushima Mycological Memoirs 5. Published by the author, Kobe, Japan. 100 pp.

McKenzie EHC, Hyde KD. 1997. Microfungi on *Pandanaceae*. In: KD Hyde (ed.) Biodiversity of tropical microfungi. Pp. 157–177. Hong Kong University Press.

McKenzie EHC, Thongkantha S, Lumyong S. 2007. *Zygosporium bioblitzi* sp. nov. on dead leaves of *Cortaderia* and *Dracaena*. New Zealand Journal of Botany 45: 433–435.

Moore RT. 1959. The genus *Berkleasmium*. Mycologia 51: 734-739.

Photita W, Lumyong P, McKenzie EHC, Hyde KD, Lumyong S. 2002. A new *Dictyosporium* species from *Musa acuminata* in Thailand. Mycotaxon 82: 415–419.

Pinnoi A, Jeewon R, Sakayaroj J, Hyde KD, Jones EBG. 2007. *Berkleasmium crunisia* sp. nov. and its phylogenetic affinities to the *Pleosporales* based on 18S and 28S rDNA sequence analyses. Mycologia 99: 378–384.

Somrithipol S, Jones EBG. 2003. *Berkleasmium typhae* sp. nov., a new hyphomycete on narrow-leaved cattail (*Typha angustifolia*) from Thailand. Fungal Diversity 12: 169–172.

Taylor JE, Hyde KD. 2003. Microfungi of tropical and temperate palms. Fungal Diversity Research Series 12.

Whitton SR, McKenzie EHC, Hyde KD. 2003. Microfungi on the *Pandanaceae*: *Zygosporium*, a review of the genus and two new species. Fungal Diversity 12: 207–222.

Zhao G-Z, Zhang T-Y. 2003. Notes on dictyosporic hyphomycetes from China I. The genus *Dictyosporium*. Mycosystema 22: 19–22.

Zhao G-Z, Zhang T-Y. 2004. Notes on dictyosporic hyphomycetes from China IV. The genus *Berkleasmium*. Mycotaxon 89: 241–244.

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Alternaria undulata, a new species from *Citrus sinensis*

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Abstract — A new species, *A. undulata,* is described from fruit of *Citrus sinensis* (navel orange) imported into USA from Australia. *A. undulata* was associated with visible lesions that appeared to originate from the peduncular scars of several fruit purchased from a retail display in a local grocery store. The wavy appearance of primary and secondary conidiophores produced in potato-carrot agar cultures is the diagnostic character by which this species can be recognized. Cluster analyses of DNA fingerprint data sets support the inclusion of *A. undulata* in the *A. infectoria* species-group and its segregation from other members of this group.

Key words — decay, sporulation pattern

Introduction

In 2003 fruit of *Citrus sinensis* (L.) Osbeck (navel orange) for sale at a local grocery store were observed to have symptoms of a peel disorder surrounding the peduncular scar, symptoms not previously observed on citrus fruit by the author. Isolation procedures in the laboratory consistently yielded *Alternaria* spp. Several isolates had cultural characteristics and the sporulation pattern observable at 50× typical of the *A. infectoria* species-group (Simmons & Roberts 1993). Microscopic observation and molecular (fingerprint) analyses of these and other *A. infectoria* species-group isolates (Roberts 2007) confirmed both their group affinity and unique identity. Consequently, these *A. infectoria* species-group isolates from *Citrus* are described as a new species, *A. undulata*.

Materials and methods

Conditions of isolation, culture and observation. In 2003, an apparent peel disorder was observed on navel orange fruit in a retail display at a grocery store in Wenatchee, WA (Fig. 1). Several affected fruit were purchased and brought to the laboratory where they were surface disinfested by swabbing with 70% aqueous ethanol. The surface-disinfested fruit were then cut open with a sterile

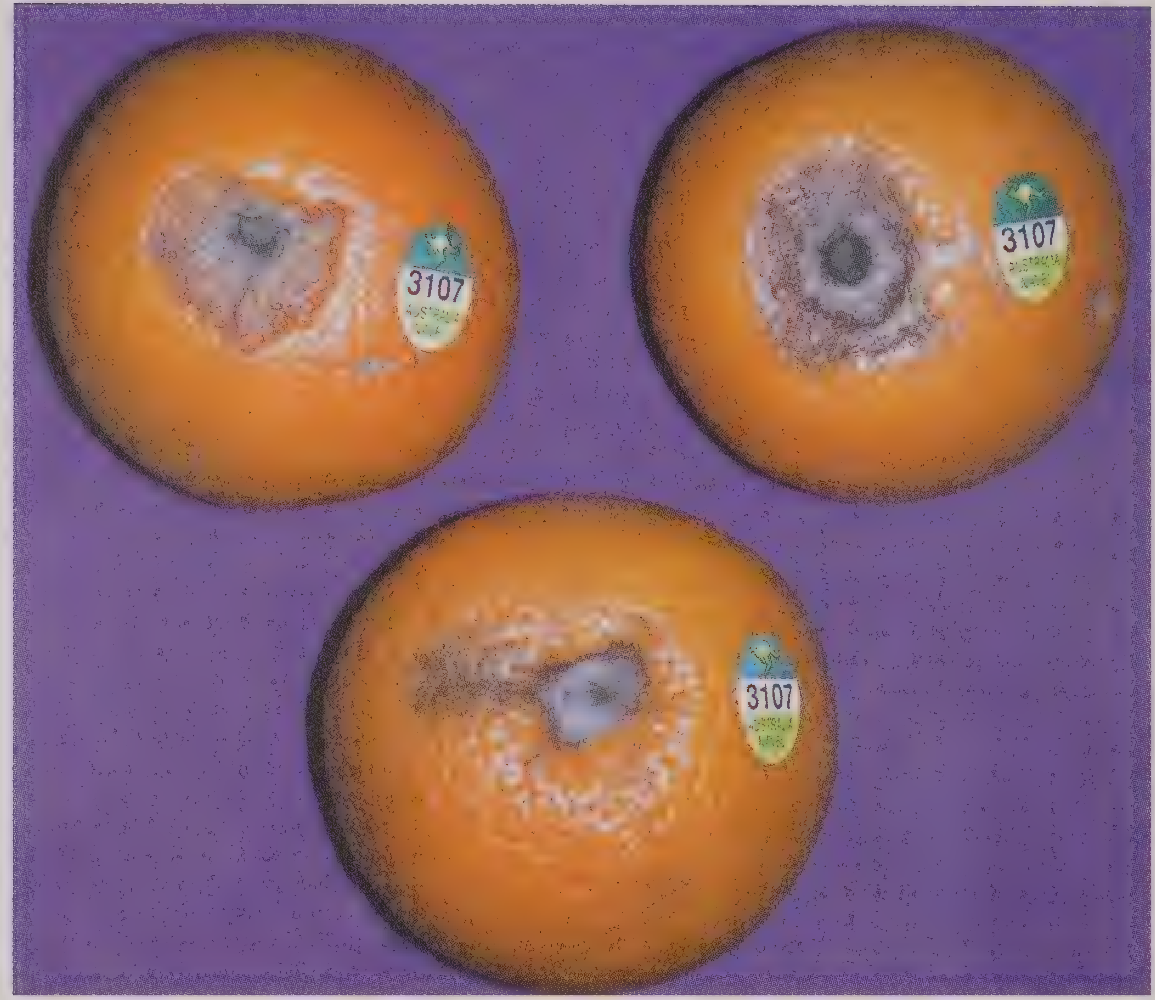

Fig. 1. Orange fruit with stem-end symptoms and signs from which *Alternaria undulata* and other *Alternaria* spp. were isolated.

scalpel, and small bits of symptomatic tissue were transferred to potato carrot agar plates (PCA, Simmons & Roberts, 1993). A number of isolates were obtained from this tissue and preserved as lyophilized conidial suspensions held at -20 C. All media, methods and conditions for subsequent growth and observation of *Alternaria* follow those in Simmons & Roberts (1993:136-137) and Roberts (2007).

Cultures were examined at 50× using a stereoscopic microscope. The majority of isolates developed a pattern of sporulation typical of the *A. tenuissima* species-group, but two isolates exhibited a pattern of sporulation typical of the *A. infectoria* species-group (Simmons & Roberts 1993). For microscopic examination, slide preparations were made using a double-stick tape method. Two drops of lactic acid were placed onto a glass microscope slide, then a loop of double-stick tape was pressed onto the surface of the culture. The tape with attached mycelium and conidia was mounted conidium-side up onto the drops of lactic acid. One or two additional drops of lactic acid were placed onto the mounted tape and covered with a 22 × 50 mm cover slip. The slide was gently heated over a flame until the lactic acid spread out to the limits of the cover slip. Excess lactic acid was removed with bibulous paper. Microscopic images were recorded digitally using a Zeiss Axiocam Mr5a camera mounted on a Zeiss Axioplan microscope. Morphometric measurements were made from calibrated digital images using Image-Pro Plus 4.2 software (Media Cybernetics, Bethesda, MD) and recorded and analyzed using Excel (Microsoft Corp., Redmond, WA). Composite images were created from multiple digital images with Photoshop (Adobe Systems, San Jose, CA), and in some instances, serial images through several planes of focus were combined to provide in-focus representative images of conidia and conidiophores. Color references in the taxonomic descriptions are to the corresponding color plates in the Methuen Handbook of Colour (Kornerup & Wanscher 1989).

Molecular analysis. Cultures were grown and DNA was prepared for analysis by methods reported previously (Roberts et al. 2000, Roberts 2007). Methods and protocols for analysis of RAPD, RAMS and AFLP fingerprints also followed Roberts (2007), to which the reader is referred for details.

Taxonomic description

Alternaria undulata R.G. Roberts, **sp. nov.**

MYCOBANK MB 511242

Etym.: *undulatus* - undulate; having an uneven, alternately convex and concave margin; referring to the primary and secondary conidiophores.

Ex cultura in agaro PCA post 7 dies, temperatura 21 C descripta. Coloniae ca. 32 mm diam. Conidiophora primaria simplicia vel multiramosa, geniculata, plerumque undulata, 58-200 x 4-5.5 μm. Conidia in juventute subglobosa vel ovoidea, in maturitate ovoidea vel obpyriformibus, erostrata, 13.0-50.0 x 7.8-18.4 μm, transverse ad 8-euseptata, interne distoseptata, conidiophoris secondariis apicalibus et lateralibus, simplicibus vel ramosis, geniculatis, ad 80 μm longis. Conidia laevia vel punctata vel verruculosa, initio hyalina vel dilute brunneola, dein atrobrunnea.

Colony diameters after 7 days at 21 C and 8/16 hrs of light/dark about 32 mm on PCA and V8-juice agar, about 25 mm on hay decoction agar. On PCA primary conidiophores often highly branched, light brown (7D4) but lighter, near reddish gray (7B2) at septa, 58 - 200 × 4 - 5.5 μm, simple or branched, geniculate, undulate. Conidia initially or persistently without ornamentation, more often becoming verruculose to punctate, especially on the proximal half of the conidium body, initially hyaline to very pale brown, becoming dark brown in age. Conidia 13 - 50 × 8 - 18 μm (basal conidia 30-50 μm long), erostrate, subglobose to ovoid when young, ovoid to obpyriform with age, developing apical and lateral secondary conidiophores that are 7 - 80 × 4 - 5 μm, simple or branched, geniculate, and frequently undulate. Sporulation architecture open due to secondary conidiophore elongation between successive conidia,

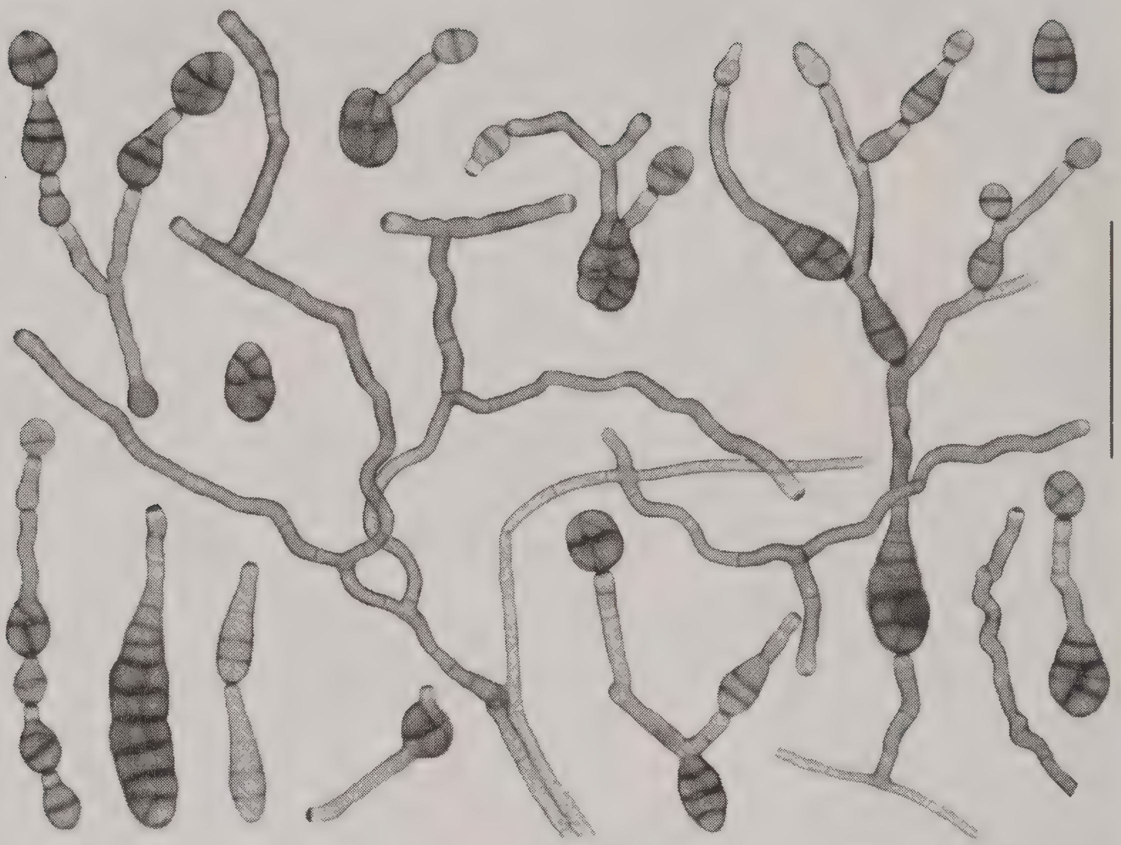

Fig. 2. Conidia and conidiophores of *A. undulata* from potato carrot agar. Bar = 50 μm.

with several hundred conidia produced in age from basal conidia. The smallest conidia regularly produce secondary conidiophores without forming spore body transverse septa. The largest fully developed conidia exhibit up to nine transverse eusepta, with distosepta often occurring within the segments formed by eusepta. The outlines of mature conidia are usually constricted at 3-5 primary eusepta. Repeated conidiogenesis and associated production, elongation, and branching of secondary conidiophores produce a pattern of sporulation consistent with the *A. infectoria* species group (Simmons & Roberts 1993).

Holotype: BPI 878242 (dried culture preparation ex RGR 03.0061, isol. Roberts from peduncular lesion of *Citrus sinensis*, local market, Wenatchee, WA U.S.A., 2003; original source likely Australia. Ex-type CBS 121922 (RGR 03.0061).

Discussion

The undulating appearance of primary and secondary conidiophores from PCA cultures is immediately noticed upon microscopic examination of tape preparations, and has been a consistent morphologic character for these isolates since their isolation. The expression of this character is medium-dependent, and is diminished or absent if these isolates are grown on PCA that was not strictly prepared according to the method described by Simmons (1992). Specifically, it is critically important that during preparation of the PCA the autoclaved potatoes and carrots are forced through a sieve and then reincorporated into the media before re-autoclaving. In other words, no filtration of the sieved potato-carrot mixture should occur. Otherwise, this character is likely to be missed.

The unique appearance of the conidiophores of *A. undulata* on PCA is sufficiently stable to warrant description of these two isolates as a new species based upon this character. Although *A. undulata* is not included in Simmons' (2007) key for the *A. infectoria* species-group, the key is still useful, as *A. undulata* does not key out to any of the 32 species treated in the key. On PCA, conidia are produced in 'open' clumps from relatively elongated secondary conidiophores, conidium color is not blue or unstable, the maximum conidium size is less that 60 mm, a single sporulation clump of *A. undulata* can contain hundreds of conidia and *A. undulata* produces zonate colonies. Application of the these character states to Simmons' key directs the user to four possible species names, each differentiated by size of primary conidia. All four species, *A. viburni, A. herbiphorbicola, A. infectoria* and *A. hordeiaustralica*, produce primary conidia that are narrower than the widest conidia produced by *A. undulata* (18 mm) and, excepting *A. hordeiaustralica*, are shorter.

In a previous cluster analysis of combined DNA fingerprint data sets (RAPD, AFLP, microsatellite) two isolates of *A. undulata*, RGR 03.0061 and RGR 03.0059, were shown to cluster among other *A. infectoria* species-group isolates (Fig. 4, Roberts 2007). The topology of this species-group cluster also supports the morphological segregation of *A. undulata* from other species within this group and among other *Alternaria* species studied to date.

Koch's postulates were not fulfilled or attempted due to the unavailability of demonstrably sterile or fungicide-free orange fruit and a total lack of knowledge of the disease etiology, so *A. undulata* cannot at this time be considered the sole etiologic agent of this disease. Because the two extant isolates of *A. undulata* were isolated from lesions with similar appearances but from different fruits, there is at least an implied risk of transporting this species via commercial shipments of citrus fruit.

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The ongoing contribution of E.G Simmons to the author's research is greatly appreciated. For this manuscript, Simmons' constructive comments, critical review and Latin description are specifically acknowledged. The author also gratefully acknowledges Mary E. Palm for her thoughtful and thorough review for this manuscript. As always, the efforts of Steve Reymond during all phases of the research are acknowledged and appreciated.

Literature cited

Kornerup A, Wanscher JH. 1989. Methuen Handbook of Colour, 3rd ed. Methuen: London (UK). 252 pp.

Roberts RG. 2007. Two new species of *Alternaria* from pear fruit. Mycotaxon 100: 159-167.

Roberts RG, Reymond ST, Andersen B. 2000. RAPD fragment pattern analysis and morphological segregation of small-spored *Alternaria* species and species-groups. Mycol. Res. 104:151-160.

Simmons EG. 1992. *Alternaria* taxonomy: Current Status, Viewpoint, Challenge. In: *Alternaria* Biology, Plant Diseases and Metabolites (Eds. Chelkowsi, Visconti) Elsevier, Amsterdam. pp 1-36.

Simmons EG. 2007. *Alternaria*: An Identification Manual, CBS Biodiversity Series No.6. CBS Fungal Biodiversity Centre: Utrecht. 775 pp.

Simmons EG, Roberts RG. 1993. *Alternaria* Themes and Variations (73). Mycotaxon 48: 109-140.

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Xanthoparmelia pustulosa (*Parmeliaceae*), a lichen new to Asia

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Abstract—*Xanthoparmelia pustulosa* is a lichenized fungus previously known only from the Canary Islands and North America. It is new to Turkey and Asia. A short description and data are presented.

Keywords—*Ascomycota*, Erzincan

In recent years many new lichen taxa have been recorded for Turkey since the lichen flora is poorly known (Dogru & Guvenc 2007, Yazici & Aptroot 2007, Yazici et al. 2007a,b). Generic concepts in the parmelioid lichens have been discussed intensively during the past three decades (Blanco et al. 2004, Elix 1994, 2003; Elix & Schumm 2003, Esslinger 2000). *Xanthoparmelia* sens. lat. (including *Neofuscelia* Essl.) is a particularly speciose genus and detailed studies on this group are continuing (Blanco et al. 2004). Recent molecular studies have shown that *Neofuscelia pustulosa* is nested within *Xanthoparmelia* like a number of other species previously accommodated in *Neofuscelia* (Blanco et al. 2004). All such species contain *Xanthoparmelia*-type lichenan.

After drying at room temperature, the lichen specimen was examined using a Zeiss Stemi 2000C stereo microscope. Chemical constituents were identified by thin layer chromatography (Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

Results

Xanthoparmelia pustulosa (Essl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch, Taxon 53: 970.2004.

Syn. *Parmelia pustulosa* Essl., J. Hattori Bot. Lab. 42: 139. 1977.
Neofuscelia pustulosa (Essl.) Essl., Mycotaxon 7: 52. 1978.

Thallus foliose, ± adpressed throughout, moderately or loosely adnate, to 6 cm in diameter, cell walls containing *Xanthoparmelia*–type lichenan. Lobes 1–3 mm wide, flat, short and rounded, contiguous to imbricate. Upper surface olive–brown to dark–brown; ± smooth to slightly indented or weakly wrinkled, strongly rugose towards the centre; isidiate, soredia and pseudocyphellae absent; isidia usually somewhat clustered in pustulate outgrowths mainly in the centre, the isidia postulate, globose or elongate, easily abraded and broken, 0.1–0.3 mm in diameter. Medulla white. Lower surface pale tan to pale brown; ± dull and smooth; the rhizines concolorous with the lower surface or darkening slightly, to 0.7 mm long. Apothecia absent. Pycnidia uncommon; conidia 5–6 × 1μm, weakly bifusiform. Cortex K–, N+ dark blue–green; medulla P–, K–, C–, KC– or KC + red turning orange–red; glomelliferic acid (major) and glomellic (submajor) acid present.

Xanthoparmelia pustulosa was known previously from the Canary Islands and North America (Esslinger 1977). In Turkey this species grows on siliceous rocks in a xeric–inland area.

Erzincan: Çayırlı: Karahüseyin village, 39°43'N, 40°11'E, on siliceous rock, 2100 m, 17 October 2001, *Yazici 1293.*

ECOLOGY OF THE SURVEY AREA.–The present area is grassland bearing a steppe vegetation with an uneven cover of short grasses present in spring, remote from ephemeral streams. The well–lit site is occasionally exposed to strong winds in winter and lacks any substantive forest cover. Scattered *Populus, Salix* and *Quercus* occur along the streams. The area is typically characterized by a continental climate with dry and short summers and cold and severe winters. Rainfall averages 366.6 mm per year, with the highest rainfall occurring in December and January (408 mm) and the lowest in July (210 mm). The average relative humidity is 60% and the average temperature 10.3 °C, with the lowest temperature in January (29.5°C) and the highest in August (37°C).

REMARKS—*Xanthoparmelia pustulosa* is very similar to *Xanthoparmelia loxodes* (Nyl) O. Blanco et., but is distinguished by the pale lower surface (black in *X. loxodes*).

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References

Blanco O, Crespo A, Elix JA, Hawksworth DL, Lumbsch HT. 2004: A molecular phylogeny and a new classification of parmelioid lichens containing *Xanthoparmelia*–type lichenan (*Ascomycota: Lecanorales*). Taxon 53 (4): 959–975.

Dogru Z, Guvenc S. 2007: Lichenized and lichenicolous fungi from Bursa province new to Turkey. Mycotaxon 102: 389-394. 2007.

Elix JA. 1994: *Xanthoparmelia*. Flora of Australia 55: 201–308.

Elix JA. 2003: The lichen genus *Paraparmelia*, a synonym of *Xanthoparmelia* (*Ascomycota, Parmeliaceae*). *Mycotaxon* 87: 395–403.

Elix JA, Ernst–Russell KD. 1993: A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances (2nd ed.). Australian National University, Canberra.

Elix JA, Giralt M, Wardlaw JH. 2003: New chloro-depsides from the lichen *Dimelaena radiata*. Bibliotheca Lichenologica 86: 1-7.

Elix JA, Schumm F. 2003: New species and new records in the lichen family *Parmeliaceae* (*Ascomycota*) from Macaronesia. Mycotaxon 86: 383–388.

Esslinger TL. 1977: A chemosystematic revision of the brown *Parmeliae*. Journal of the Hattori Botanical Laboratory 42: 1–211.

Esslinger TL. 2000: Notes on the brown–colored species of *Parmeliaceae* (lichenized *Ascomycota*) in Southern Africa. Bryologist 103 (3): 568–591.

Yazıcı K, Aptroot A. 2007: Five lichens new to Turkey. Mycotaxon 100: 21–26.

Yazıcı K, Aptroot A, Aslan A. 2007a: Six lichenized and non–lichenized fungi new to Turkey. Mycotaxon 102: 307–313.

Yazıcı K, Aptroot A, Aslan A. 2007b: Lichen biota of Zonguldak, Turkey. Mycotaxon 102: 257–260.

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Mycodiversity studies in selected ecosystems of Greece: 4. Macrofungi from *Abies cephalonica* forests and other intermixed tree species (Oxya Mt., central Greece)

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Abstract — In the course of a nine-year inventory in Mt. Oxya (central Greece) fir forests, a total of 358 taxa of macromycetes, belonging in 149 genera, have been recorded. Ninety-eight taxa constitute new records, and five of them are first reports for the respective genera (*Athelopsis, Crustoderma, Lentaria, Protodontia, Urnula*). One hundred and one records for habitat/host/substrate are new for Greece, while some of these associations are reported for the first time in literature. Full text can be accessed at http://www.mycotaxon.com/resources/weblists.html.

Key words — biodiversity, Mediterranean region, mushrooms

Introduction

The data presented in this work derive from a nine-year research study (1996-2004) on the macromycetes of the fir (*Abies cephalonica*) forests growing on the eastern slope of the Oxya Mt. (central Greece). Detailed information about Oxya Mt. (forests distribution, edaphic and climatic data) was presented in the first part of this study (Dimou et al. 2002). The fir grows in altitudes of 840 to 1,300 m a.s.l., and it is succeeded by the alpine zone in the northern and southern part of the mountain and by *Fagus* forests in the central region. In lower altitudes, *Castanea sativa* and *Quercus* spp. are intermixed, while compact *Pinus nigra* stands were established by reforestation in two locations of this zone. Other tree species scattered within the fir forest are *Acer pseudoplatanus*, *Platanus orientalis*, *Prunus cocomilia*, *Carpinus orientalis*, *Populus* spp., *Cornus*

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spp., *Salix* spp., *Juniperus* spp. (forming distinct plant communities in some locations), *Ostrya carpinifolia*, *Alnus glutinosa*, and *Robinia pseudoacacia*.

Methodology

Mushrooms were inventoried in various localities of the *Abies cephalonica* forests on the eastern side of Oxya Mt., but three areas and five sites (between the villages Gardiki and Grammeni Oxya) were systematically investigated. Field parameters, macroscopic characteristics and some macro-chemical reactions of the collected specimens were recorded in situ. Microscopic observations and micro-chemical reactions were carried out as described in Dimou et al. (2002). Vouchers of all species recorded during this study are deposited in the herbarium of LGAM-AUA (Laboratory of General and Agricultural Microbiology-Agricultural University of Athens). A photographic archive is also maintained. Greek geographical names cited are those used in modern Greek ("dimotiki") that are transliterated following the international standard ISO 843 (1999). Specimens were identified and classified primarily based on the following: Bas et al. (1988-95), Bigelow (1982, 1985), Bon (1991), Breitenbach & Kränzlin (1984-2000), Brandrud et al. (1989-98), Eriksson & Ryvarden (1973-76), Eriksson et al. (1978-88), Hansen & Knudsen (1997-2000), Hjortstam et al. (1987-88), Jacquetant (1984), Jülich (1984), Kõljalg (1996), Kuyper (1986), Martin (1996), Montecchi & Sarasini (2000), Moser (1983), Nauta (1987), Noordeloos et al. (2001), Ryvarden & Gilbertson (1993), Sarnari (1998).

Results and discussion

This inventory resulted at the identification of 358 macrofungal species and varieties, among which 23 were *Ascomycetes* and 335 were *Basidiomycetes*, belonging in 149 genera. Ninety-eight taxa constitute new records for Greece, of which 92 are presented here for the first time (the habitat/host/substrate in parentheses when not *Abies cephalonica*):

Agaricus impudicus (in grass under *Juglans regia*), *A. langei* (in *Castanea sativa* orchard), *Agrocybe pediades* f. *cinctula, Amanita spissa, Antrodia juniperina, Athelopsis subinconspicua, Boletus fechtneri* (mixed *Abies–Quercus* stands), *Ceriporia viridans, Chalciporus hypochryseus, Clitocybe amarescens* (*Abies* mixed with *Quercus*), *C. subsinopica, Coltricia cinnamomea, Conocybe digitalina* (*Abies* and in mixed stands with *Quercus*), *C. kuehneriana, Cortinarius calochrous* subsp. *coniferarum* var. *barbaricus, C. cinnamomeoluteus, C. dionysae, C. huronensis, C. mucifluus, C. norvegicus, C. spadicellus, C. splendens* ssp. *meinhardii, Crustoderma dryinum* (unidentified wood under mixed tree spp.), *Cystoderma adnatifolium, C. tuomikoskii, Dacrymyces estonicus* (on dead *Pinus nigra* twigs), *Entoloma rhodocylix, E. rhodopolium* f. *rhodopolium* (mixed *Castanea, Quercus* and *Abies*), *Galerina badipes, G. uncialis* (on decaying branches of *Pinus nigra*), *Gymnopus ocior, Hebeloma perpallidum, Hydnellum spongiosipes* (*Abies* mixed with *Fagus*), *Hygrocybe phaeococcinea* (on the ground covered with *Parmelia*, under mixed *Abies-Platanus* stands), *Hygrophorus atramentosus, H. hyacinthinus, H. latitabundus* (mixed *Juniperus oxycedrus, Pinus nigra* and *Quercus* stands), *H. ponderatus* (mixed *Quercus frainetto, Castanea sativa* and *Abies* stands), *Inocybe adaequata, I. curvipes, I. flocculosa, I. mixtilis, I. nitidiuscula, I. splendens* var. *phaeoleuca, I. splendens, I. whitei* (mixed *Abies-Castanea*), *Lachnellula gallica, Lactarius leonis, Lentaria epichnoa* (*Pinus nigra* needle litter), *Lepiota Echinacea, Macrolepiota prominens, Melanoleuca bresadolae* (in alpine zone on soil rich in sheep manure), *M. cognata* var. *pallidipes* (in alpine zone on soil rich in sheep manure), *M. crassotunicata, M. exscissa, M. favrei, M. grammopodia* (in alpine zone on soil rich in sheep manure), *M. pallidipes* (mixed *Abies cephalonica, Quercus* and *Castanea* stands), *M. polioleuca* f. *langei, M. polioleuca* f. *polioleuca, M. queletii* (mixed *Pinus nigra-Robinia pseudoacacia*), *M. substrictipes* (in alpine zone on soil rich in sheep manure), *Morchella costata* f. *acuminata* (mixed *Abies-Platanus-Alnus* and *Abies-Castanea*), *M. eximia* f. *schizocostata* (mixed *Abies-Castanea*), *M. intermedia, Mycena amicta, M. epipterygia* var. *epipterygioides* (needle litter under *Pinus nigra*), *Myxarium nucleatum* (decorticated, decomposing trunk of *Platanus orientalis*), *Panellus violaceofulvus, Peniophora nuda* (on dead branches of *Platanus orientalis*), *P. rufomarginata* (on dead *Quercus frainetto* branch), *Phanerochaete jose-ferreirae* (on barkless branch of *Quercus frainetto*), *Pholiota heteroclita* (on *Quercus* sawdust), *Pluteus primus, Protodontia subgelatinosa, Rhizopogon marchii* (under *Pinus nigra* mixed with *Robinia pseudoacacia* or *Juniperus oxycedrus*), *Russula anthracina* var. *insipida, R. emetica* var. *silvestris, R. firmula, R. galochroa* (mixed *Abies cephalonica-Castanea sativa*), *R. hortensis, R. mustelina, R. nauseosa* (mixed *Abies-Castanea*), *R. olivina, R. sphagnophila, R. subfoetens* var. *grata, Schizopora flavipora* (on decorticated branch of *Quercus frainetto*), *Steccherinum oreophilum, Suillus leptopus* f. *litoralis* (mixed *Pinus nigra-Abies cephalonica-Robinia pseudoacacia*), *Tomentella atramentaria, Tricholoma triste, Tuber uncinatum*, and *Urnula pouchetii.*

In addition, 101 taxa records represent new habitat/host/substrate reports for Greece. Some fungi (*Antrodia juniperina, Amylostereum laevigatum, Protodontia subgelatinosa, Steccherinum oreophilum, Peniophora rufomarginata, Phellinus pini Russula sphagnophila, Lyophyllum fumosum*) were recorded in/on new habitat/host/substrate hitherto not reported in the literature. Moreover, *Suillus leptopus* f. *litoralis* was recorded in this mountainous area, although it is known to occur in coastal areas.

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Literature cited

Bas C, Kuyper ThW, Noordeloos ME, Vellinga EC (eds.). 1988-1995. Flora Agaricina Neerlandica, vols 1-3. A.A. Balkema, Rotterdam.

Bigelow HE. 1982, 1985. North American species of *Clitocybe* Part I & II, 471 p. J. Cramer, Vaduz.

Bon M. 1991. Les Tricholomes et ressemblants, 163 p. Association d' Ecologie et Mycologie, Amiens.

Breitenbach J, Kränzlin F. 1984-2000. The Fungi of Switzerland, Vols 1-5. Mycologia Luzerne, Lucerne.

Brandrud TE, Lindström H, Marklund H, Melot J, Muskos S. 1989-1998. *Cortinarius*, Flora Photographica.

Dimou, DM, Zervakis GJ, Polemis E. 2002. Mycodiversity studies in selected ecosystems of Greece: I. Macrofungi from the southernmost *Fagus* forest in the Balkans (Oxya Mountain, central Greece). Mycotaxon 81: 177-207.

Eriksson J, Ryvarden L. 1973-1976. The *Corticiaceae* of North Europe, Vols 2-4. Fungiflora Oslo.

Eriksson J, Hjortstam K, Ryvarden L. 1978-1988. The *Corticiaceae* of North Europe, Vols 5-7. Fungiflora Oslo.

Hansen L, Knudsen H (eds) 1997-2000. Nordic Macromycetes, vol. 1-3. Nordsvamp, Copenhagen.

Hjortstam K, Larsson K-H, Ryvarden L. 1987, 1988. The *Corticiaceae* of North Europe, Vols 1 & 8. Fungiflora Oslo.

Jacquetant E. 1984. Les Morilles, 114 p. La Bibliothèque des Arts, Paris.

Jülich W. 1984. Die Nichtblätterpilze Gallertpilze und Bauchpilze. Gustav Fischer Verlag, Stuttgard.

Kõljalg U. 1996. *Tomentella* (*Basidiomycota*) and related genera in Temperate Eurasia. Synopsis Fugorum vol. 9 , 213 p., Fungiflora, Oslo.

Kuyper ThW. 1986. A revision of the genus *Inocybe* in Europe. I. Subgenus *Inosperma* and the smooth-spored species of the Subgenus *Inocybe*. Persoonia-Supplement vol. 3, 247 p.

International Standard ISO 843. 1999. Information and documentation – Conversion of Greek characters into Latin characters, 2nd edition, 12 p. International Organization for Standardization, Geneve.

Martin P. 1996. The genus *Rhizopogon* in Europe, 153 p., Edicions especials de la Societat Catalana de Micologia vol. 5, Societat Catalana de Micologia.

Montecchi A,Sarasini M. 2000. Funghi Ipogei d' Europa, 714 p., Associazione Micologica Bresadola, Trento.

Moser M. 1983. Key to Agarics and Boleti, English translation from the 4th edn., 535 p. R. Phillips, Tonbridge.

Nauta MM. 1987. Revisie van de in Nederland voorkomende soorten van het geslacht *Agrocybe*. Rijksherbarium, Leiden (Holland).

Noordeloos ME, Kuyper ThW, Vellinga EC (eds.) 2001. Flora Agaricina Neerlandica, vol. 5, 170 p., A.A. Balkema Publishers, Lisse, Netherlands.

Ryvarden L, Gilbertson RL. 1993. European Polypores, vols 1-2, 743 p. Fungiflora, Oslo.

Sarnari M. 1998. Monografia illustrata del Genere *Russula* in Europa, 799 p., Associazione Micologica Bresadola, Trento.

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Inocybe martinica: a new record from South America and type studies of allied species from the Lesser Antilles

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Abstract — *Inocybe martinica* is recorded for the first time from South America. Type studies of three species described by Pegler from the Lesser Antilles, *I. antillana*, *I. crassicystidiata* and *I. martinica*, and a key for them are provided for comparison.

Key words — *Agaricales*, *Inocybaceae*, neotropics, taxonomy

Introduction

Inocybe (Fr.) Fr. is an ectomycorrhizal genus of brown spored mushrooms belonging to the family *Inocybaceae* Jülich, order *Agaricales* Clements (Matheny 2005, Matheny & Bougher 2006). In Brazil, few species have been reported. In the southern region, Singer (1953), Rick (1961) and Cortez & Coelho (2005) report *I. curvipes* P. Karst., *I. hyperythra* Rick and *I. violaceolamellata* Rick from the State of Rio Grande do Sul; Stijve & de Meijer (1993) and de Meijer (2001, 2006) listed *I. curvipes*, *I.* cf. *australiensis* Cleland & Cheel, *I.* aff. *cingulatipes* (Corner & E. Horak) Garrido, *I.* aff. *conspicuispora* Buyck & Eyssart., *I.* aff. *crassicystidiata* Pegler, *I.* aff. *incognita* (E. Horak) Garrido, *I.* aff. *pahangi* (Corner & E. Horak) Garrido and *I.* aff. *xerophytica* Pegler from Paraná State; and Giachini et al. (2000) cited *I. australiensis* from Santa Catarina State. In the northern region only one species was recorded, *I. amazoniensis* Singer & I.J. Araujo, from the State of Amazonas (Singer et al. 1983).

We describe here an interesting species collected in the Atlantic Forest from the State of Pernambuco, Northeast Brazil. For a better understanding a comparison has been made with the type specimens of Antillean *Inocybe* spp. having stipes that are covered in metuloids.

Material and methods

Basidiomata were collected in forest fragments located at the "Usina São José" (7°50'20"S 35°00'10"W), Municipality of Igarassu, Pernambuco State, Northeast

Brazil. The area comprises approximately 24000 ha, of which 8000 ha are forest fragments with different conservation stages (SECTMA 2001).

The usual methodology for analysis of agaric fungi was followed (Singer 1986). The quotient of the length/width of basidiospores is presented as the Q value. Color naming and codes follow Maerz & Paul (1950). The specimens are deposited at Herbarium URM, Department of Mycology, "Universidade Federal de Pernambuco," Recife.

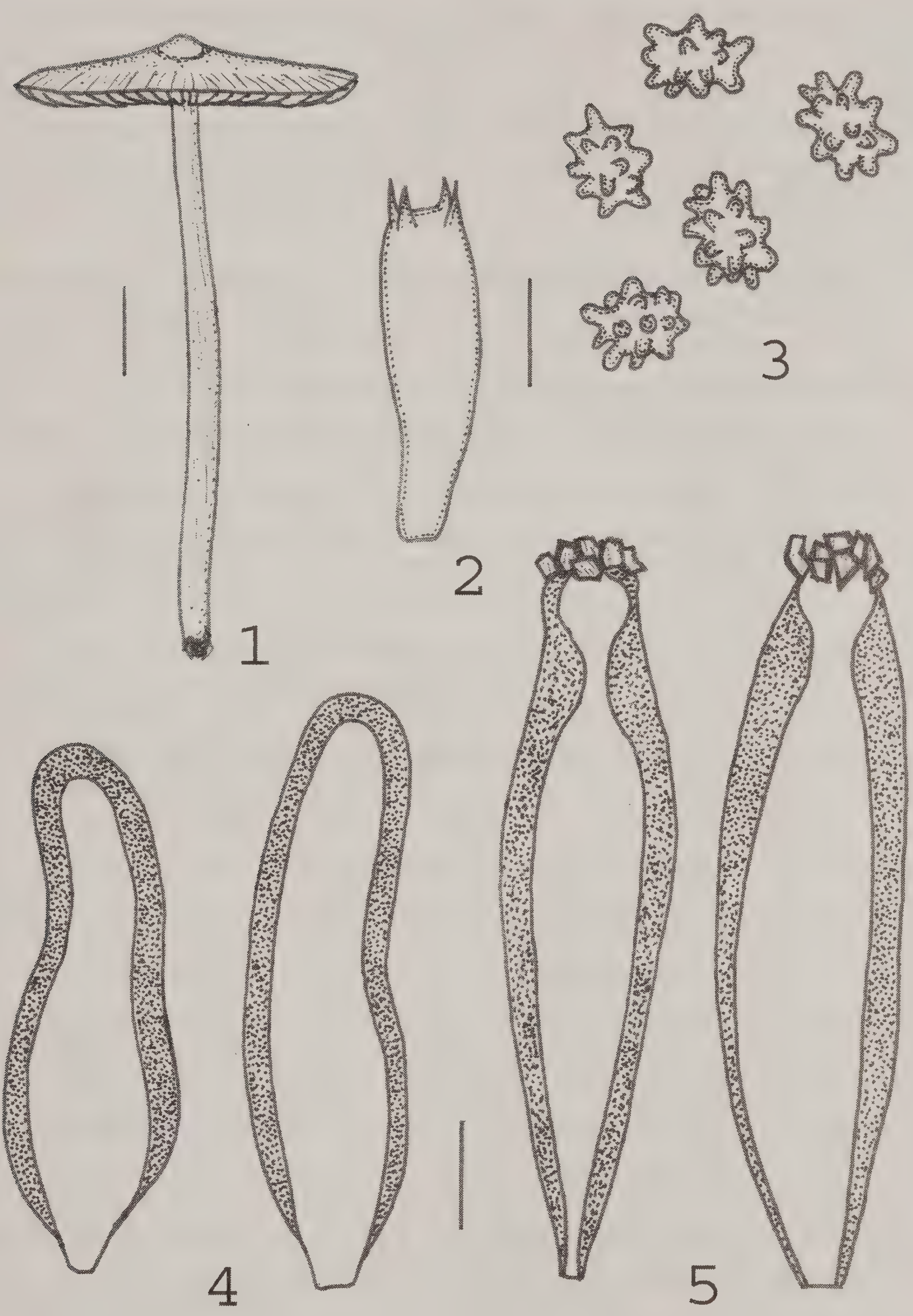
Taxonomy

Inocybe martinica Pegler, Kew Bull. Add. Ser 9: 539. 1983. FIGS. 1-5

PILEUS 20–38 mm, convex sub-conical then plane with a pronounced and obtuse umbo; color of surface gold yellowish brown (between M&P 11J6 "Honey-sweet" and 11J7 "Inca Gold"), slightly pallid in young specimens, with concolorous or slightly darker (at least in dry specimens) small fibrils, appearing distinctly fibrillose-squamulose in dried specimens, except for the somewhat glabrous centre in the larger basidiomata; margin entire when young, turning short striate in mature specimens; context thin, fleshy. LAMELLAE adnexed, subdistant, pale brown (M&P 15L10 "Whippet") when mature, edges slightly fimbriate, with some lamellulae. STIPE 28–60 × 4–5 mm, central, cylindrical even, without a marginate bulb, base not at all bulbous, cortina absent, surface pale cream color then beige (M&P 11I5 "Chamois"), pruinose the entire length of the stipe surface, turning more evident in dried state; context fleshy.

BASIDIOSPORES (9–)9.5–11.5(–12) × 5.5–7.5(–8) µm, average 9.9 × 6.8 µm, Q = (1.25–)1.31–1.67(–1.82), average Q = 1.49, elongate ellipsoid with a slight suprahilar depression in side view, with 11-15 prominent subconical to more frequently obtuse nodules, brownish or ochraceous brown in KOH. BASIDIA 25–36 × 7.5–10 µm, clavate, with four sterigmata, hyaline. PLEUROCYSTIDIA 55–70 × 17–23 µm, metuloid, fusiform to narrowly lageniform with broadly obtuse apex; irregularly thickened wall 2.5–3 µm thick at middle then abruptly ranging up to 5 µm near the apex; hyaline with colorless wall, strongly incrusted with crystals at the apices. CHEILOCYSTIDIA similar to pleurocystidia. PARACYSTIDIA difficult to distinguish. CAULOCYSTIDIA metuloid in dense fasciculate tufts over entire stipe length, 37–62 × 15–20 µm, utriform to sublageniform with broadly obtuse apex, uniformly thick walled up to 2 µm, hyaline with colorless wall, without or somewhat with slight incrustation at apex. PARACAULOCYSTIDIA present, mixed with caulocystidia. PILEIPELLIS a cutis of radially arranged filamentous hyphae ranging to 7–15 µm, distinctly incrusted, thin walled, yellowish brown. CLAMP CONNECTIONS present. LAMELLAR TRAMA regular.

HABITAT: sub-gregarious and scattered on soil near members of *Clusiaceae*, *Violaceae* and *Annonaceae* (Maria Rodal, pers. commun.) in a very wet area of a tropical forest fragment.



Figures 1-5. *Inocybe martinica*. 1. Basidioma. 2. Basidium. 3. Basidiospores.
4. Caulocystidia 5. Pleurocystidia.
Scale bar 10 mm for basidioma and 10 µm for microstructures.

Material examined: BRAZIL. Pernambuco, Igarassu, "Usina São José" ("Mata de Piedade"), 07-VI-2005, *F. Wartchow 09/2005* (URM 78851).

REMARKS: The absence of a cortina, the pruinose stipe, presence of metuloids and the nodulose basidiospores place *Inocybe martinica* in section *Marginatae* Kühner, a group that Singer (1986) considered well defined. However, Matheny et al. (2002) and Matheny (2005) showed that sect. *Marginatae* is not a monophyletic group.

Inocybe martinica was originally described from Martinique in the Lesser Antilles with a pale yellowish brown pileus, thick-walled cystidia and pileipellis covered by filamentous hyphae 3-4 μm thick without incrustations. It has similar features with our collection mainly in the size of the basidiospores, viz. 8–11 × 5–7.5 μm [average 9.5 × 6.4 μm, average Q = 1.46], and the shape of cystidia (Pegler 1983).

Direct examination of the holotype of *I. martinica* [MARTINIQUE. Le Chapelle, Anse a l'Ane, 19-08-1976, J.P. Fiard 756A (K)] reveals several similarities with our material: in addition to size and shape of the basidiospores (8–)9–11 × (5–)5.5–7 μm [average 9.7 × 6.2 μm, Q = (1.35–)1.43–1.75(–1.81), average Q = 1.59], the type specimen shows the filamentous hyphae in the pileipellis (as described by Pegler) also mixed with several incrusted hyphae 8-12 (18) μm as observed in the Brazilian collection; in the dried specimens, the pileus surface is very distinctly fibrillose-squamulose. This discrepancy in the description of the pileipellis as given by Pegler in the protologue (1983: 539) may be accepted. However, Pegler equivocally uses this information to differentiate *I. martinica* from *I. crassicystidiata* (see below). Generally, the differentiation of the pileipellis is not sufficiently informative and can vary on where the section is made and the stage of development of the particular specimen (Matheny pers. corr.).

Inocybe crassicystidiata, which was described with radially arranged brown incrusted pileipellis hyphae, differs from *I. martinica* in its ochraceous ("Ochraceous-Tawny") pileus, shorter basidiospores [7.5–9 × 5.5–7.5 μm, average 8.2 × 6.2 μm and average Q = 1.30], and smaller cystidia having walls up to 5 μm thick (Pegler 1983).

Examination of the type and an additional collection of *I. crassicystidiata* [MARTINIQUE. Point Jean Claude, 20-12-1979, J.P. Fiard 850 (K Holotype); La Caravelle, 20-12-1976, J.P. Fiard 851 (K)] do not agree with the description: several cystidia have metuloids with walls 2-4 μm thick and then somewhat irregularly thickening to 4.5-6 μm, mostly near the apex, like the Brazilian collection of *I. martinica*. However the distinctly smaller basidiospores [7–9(–10) × (4.5–) 5–6.5 (–7) μm, average 8.5 × 5.7 μm, Q = (1.23–)1.25–1.70 (–1.77) average Q = 1.44] and a dried pileus surface that is less fibrillose-squamulose are good characters helpful in separating *I. martinica* from *I. crassicystidiata*. Pegler (1983) described a third Antillean species from Martinique, *I. antillana* Pegler, which he noted as having a rimose chestnut brown pileus with an underlying ochraceous context and metuloids with thinner (3 µm) walls than those found in *I. martinica* and *I. crassicystidiata*. Examination of the type [MARTINIQUE. Le Chapelle, Anse a l'Ane, 19-08-1976, J.P. Fiard 746A (K Holotype)] shows basidiospores [(7–)7.5–9(–10) × (5–)5.5–6.5(–7) µm, average 8.6 × 5.8 µm, Q = (1.36–)1.40–1.60(–1.80) average Q = 1.49] and metuloids having walls up to 4.5 µm thick. The rimose pileus cited in the original description is not sufficiently distinct in the exsiccatum.

There are other species with a pruinose stipe and metuloid caulocystidia known in tropical America. *I. matrisdei* Singer from the Bolivian Amazon is distinguished by a reddish-grayish brown pileus, smaller basidiospores [6.8–8.3 × 5.5–7.2 *µ*m], and distinctly marginate stipe bulb (Singer 1961, Singer et al. 1983). *I. tequendamae* Singer from Colombia and *I.* aff. *angustifolia* (Corner & E. Horak) Garrido and *I. neotropicalis* Singer from Costa Rica are associated with *Quercus* (Singer 1961, 1963; Singer et al. 1983).

In summary, *I. martinica* differs from the other two Antillean species by having a yellowish brown and distinctly fibrillose-squamulose pileus with squamules that persist in dried specimens and more elongated basidiospores. *Inocybe crassicystidiata* and *I. antillana* share a similar basidiospore size, but differ in the color and texture of the pileus surface. In our estimation, the thickness of cystidial walls is not sufficiently informative for species differentiation.

African members of *Inocybe* with nodulose basidiospores are quite different than *I. martinica*. Heim (1968) described *I. sclerotiicola* R. Heim & Gilles from Gabon, and Buyck & Eyssartier (1999) described two new species, *I. conspicuispora* and *I. glaucodisca* Byuck & Eyssart. However, they differ in several aspects (e.g. color of pileus, size and shape and number of nodules on the basidiospores, not to mention their distant habitats).

Other species of *Inocybe* are known in the neotropics: *I. hyperythra* from Rio Grande do Sul State, South Brazil and *I. lasseri* Dennis from Trinidad have isodiametric basidiospores with crested protuberances; both are members of sect. *Calosporae* (Dennis 1953, Singer 1953, Singer et al. 1983), although this has not been demonstrated using molecular evidence (Matheny 2005), and the stipe of *I. amazoniensis* and *I. epidendron* Matheny et al. lack metuloid caulocystidia (Singer et al. 1983, Matheny et al. 2003).

Mycorrhizal associations of *I. martinica* were not observed for our collections; in the study area, however, trees of *Caesalpiniaceae*, *Euphorbiaceae*, *Mimosaceae*, *Myrtaceae* and *Nyctaginaceae* occur (Silva & Andrade 2005), which are potentially ectomycorrhizal (Smith & Read 1997).

Artificial key for *Inocybe* species with nodulose basidiospores and an even stipe covered with metuloid caulocystidia from Lesser Antilles and northern Brazil:

1 Pileus dark chestnut brown, distinctly rimose, splitting to show an underlying ochraceous context . . . . *I. antillana*

1' Pileus yellowish brown to ochraceous, fibrillose-squamulose 2

2 Pileus yellowish brown, surface distinctly squamulose (at least in dried state); basidiospores average 9.8 × 6.5 µm . . . . *I. martinica*

2' Pileus ochraceous, only slightly fibrillose (in dried state); basidiospores average 8.5 × 5.7 µm. . . . . *I. crassicystidiata*

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References

Buyck B, Eyssartier G. 1999. Two new species of *Inocybe* (*Cortinariaceae*) from African woodland. Kew Bull. 54: 675-681.

Cortez VG, Coelho G. 2005. Additions to the mycobiota (*Agaricales*, *Basidiomycetes*) of Rio Grande do Sul, Brazil. Iheringia 60: 69-75.

Dennis RWG. 1953. Les *Agaricales* de l'Île de Trinité. Bull. Soc. Mycol. Fr. 69: 145-198.

Giachini AJ, Oliveira VL, Castellano MA, Trappe JM. 2000. Ectomycorrhizal fungi in *Eucalyptus* and *Pinus* plantations in southern Brazil. Mycologia 92: 1166-1177.

Heim R. 1968. Breves diagnoses latinae novitatum genericarum specificarumque nuper descriptarum. Cinquième série. Rev. Mycol. 33: 379-382.

Maerz AJ, Paul MR. 1950. A Dictionary of Color. 2nd ed., McGraw-Hill Book Company, Inc., New York.

Matheny PB. 2005. Improving phylogenetic inference of mushrooms with RPB1 and RPB2 nucleotide sequences (*Inocybe*, *Agaricales*). Mol. Phylogen. Evol. 35: 1-20.

Matheny PB, Bougher NL. 2006. The new genus *Auritella* from Africa and Australia (*Inocybaceae*, *Agaricales*): molecular systematics, taxonomy and historical biogeography. Mycol. Progress 5: 2-17.

Matheny PB, Liu YJ, Ammirati JF, Hall BD. 2002. Using RPB1 sequences to improve phylogenetic inference among mushrooms (*Inocybe*, *Agaricales*). Am. J. Bot. 89: 688-698.

Matheny PB, Aime MC, Henkel TW. 2003. New species of *Inocybe* from *Dicymbe* forests of Guyana. Mycol. Res. 107: 495-505 de Meijer AAR. 2001. Mycological work in the Brazilian state of Paraná. Nova Hedwigia 72: 105-159.

de Meijer AAR. 2006. A preliminary list of the macromycetes from the Brazilian State of Paraná. Bol. Mus. Bot. Municipal 68: 1-55.

Pegler DN. 1983. Agaric flora of Lesser Antilles. Kew Bull. Add. Ser. 9: 1-668.

Rick J. 1961. *Basidiomycetes* Eubasidii in Rio Grande do Sul – Brasilia. 5. Iheringia Ser. Bot. 8: 296-450

Secretaria Estadual de Ciência, Tecnologia e Meio Ambiente (SECTMA). 2001. Diagnóstico das Reservas Ecológicas: Região Metropolitana do Recife. Recife, Secretaria Estadual de Ciência, Tecnologia e Meio Ambiente do Estado de Pernambuco.

Silva AJR, Andrade LHC. 2005. Etnobotânica nordestina: estudo comparativo da relação entre comunidades e vegetação na Zona do Litoral – Mata do Estado de Pernambuco, Brasil. Acta Bot. Bras. 19: 45-60.

Singer R. 1953. Type studies on *Basidiomycetes.* VI. Lilloa 26: 57-159.

Singer R. 1961. Monographs of South American *Basidiomycetes* especially those of the east slope of the Andes and Brazil. IV. *Inocybe* in Amazon region and a supplement to part I (*Pluteus* in South America). Sydowia 15: 112-132.

Singer R. 1963. Oak mycorrhiza fungi in Colombia. Mycopathol. Mycol. Appl. 20: 239-252.

Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th ed. Koeltz Scientific Books, Stuttgart.

Singer R, Araujo IJA, Ivory MH. 1983. The ectotrophically mycorrhizal fungi of the neotropical lowlands, especially Central Amazonia. Beih. Nova Hedw. 77: 1-339.

Smith SE, Read DJ. 1997. Mycorrhizal Symbiosis. Academic Press, San Diego.

Stijve T, de Meijer AAR. 1993. Macromycetes from the State of Paraná, Brazil. 4. The Psychoactive species. Arq. Biol. Tecnol. 36: 313-329.

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Five new species of *Bulbothrix* (*Parmeliaceae*) from cerrado vegetation in São Paulo State, Brazil

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Abstract—The following new species of *Bulbothrix* are described from remnant cerrado forests in São Paulo State, Brazil: *B. cassa*, *B. lacinulata*, *B. lobarica*, *B. regnelliana* and *B. vainioi*.

Key words—*Bulbothrix apophysata, Bulbothrix meizospora, Bulbothrix sensibilis, Bulbothrix subcoronata, Bulbothrix suffixa*

Introduction

The Brazilian cerrado vegetation is a type of savanna formation, composed of a range of ecotones (the cerrados) between the arboreal forests ("cerradão" type) and grasslands called "campo limpo" (Coutinho 1978). The cerrados cover approximately two million km^2 and represent ca. 25% of Brazil, an area exceeded only by the Amazon forest. They occurred from the margins of the Amazon forest to the southeastern areas of São Paulo and Paraná States, but are concentrated in the Central Altiplane region (Ratter et al. 1997), and now represent for the most part, agricultural land.

In São Paulo State cerrado vegetation formerly occupied 20% of the territory, but the cerrado biome has now been reduced to ca. 1% of the original area (Zorzetto et al. 2003). This destruction has led to a very significant loss of biological knowledge, including that related to the lichenized mycota, since the lichens of this region are very poorly known and data on many species completely absent.

Forty-eight species of *Bulbothrix* (*Parmeliaceae*) are known world-wide (Farr et al. 1999), with the center of distribution in South America (Elix 1993, 1994). Twenty species have been reported from Brazil (Marcelli 2004), and 14 species from the small remnants of cerrado in São Paulo State (Jungbluth 2006, Jungbluth & Marcelli 2006). Recently, two new species have been proposed from Rio Grande do Sul State (Canêz 2005, Spielmann 2005, Spielmann & Marcelli 2007) and further new species will follow from the coast of São Paulo, and inland in Minas Gerais and Goiás States. In total the number of *Bulbothrix* species from Brazil will surpass 36, almost all of them occurring in the cerradoes, the probable center of diversity of the genus.

In the present paper, five new species of *Bulbothrix* from remnant cerrados in the interior of São Paulo State are described.

Material and methods

The specimens were collected from remnant cerrado vegetation mostly located in the central-east of São Paulo State (Fig. 1) between the latitudes 20°49' and 22°48'S and the longitudes 46°56' and 49°22'W; the altitudes ranged from 489 to 944 m a.s. and the climate is tropical with dry winters (Coutinho 2000).

According to our understanding, **laciniae** are thalline ramifications that are longer than wide and have truncate apices. **Lacinulae** are narrow, secondary structures growing from the laciniae. **Lobes** are wider than long and have rounded apices.

The thalline color reactions were determined by spot tests and fluorescence under UV-light (360 nm). The chemical constituents of all specimens were identified by thin-layer chromatography (TLC) using solvent C (Bungartz 2001). The holotypes were analyzed using high performance liquid chromatography (HPLC) (Elix et al. 2003) and by comparison with authentic samples.

The diagnoses refer exclusively to holotype characters and the English descriptions and comments to all the material studied.

The new species

Bulbothrix cassa Jungbluth, Marcelli & Elix, **sp. nov.** **Fig. 2**

MB 511166

Diagnosis: *Sicut* Bulbothrix ventricosa, *sed absentia acidi norstictici differt.*

Holotypus – Brazil, São Paulo State, Itirapina Municipality, Estação Experimental de Itirapina, 22°15'S 47°49'W, 770 m alt., cerrado sensu stricto inside the João Batista de Arruda Prison area, on shrub twig, *P. Jungbluth, A. A. Spielmann, L. S. Canêz* & *J. C. Sfair 840*, 24-III-2004 (SP, isotype in B).

Thallus grayish, commonly with a thin brownish border, corticolous, sublaciniate, adnate, 2–11 cm wide; sublaciniae irregularly to dichotomously branched, contiguous to imbricate, 1.0–2.5 mm wide at the base, 2.0–3.0 mm maximum width, apices rounded, margin crenate; upper surface smooth to slightly rugose; maculae punctiform abundant, but not prominent, easily confused with the abundant cicatrices left by detached isidia; cilia black, bulbate, simple, 0.1–0.2 mm long, bulbae spherical, constricted at the base, not contiguous, 0.05–0.15 mm diam., common, mainly in the axils. PUSTULAE and SOREDIA absent. ISIDIA laminal, irregularly cylindrical, simple to irregularly branched, 0.1–0.3 × <0.06 mm, caducous, erect, with brown apices, ±older isidia ornamented with bulbae. MEDULLA white. LOWER SURFACE dull to slightly shiny, black in the older parts but for the most part various shades of brown, grading into pale brown or ivory in the distal portions of the sublaciniae; prominently veined except in the distal portion of some sublaciniae, the veins becoming confluent in the proximal parts to give an rugose appearance; rhizinae 0.5–2.5 mm long, not concolorous, black at least when mature, the younger with whitish apices, simple, 0.1–0.5 mm long, abundant, evenly distributed, originating mainly from the veins, not bulbate except for those not originated from the veins, bulbate rhizines with a very shiny, small, black, sub-basal bulb. APOTHECIA laminal, adnate, small, immature, <0.5 mm diam., ecoronate, amphithecia not pycnidiate, margin crenate, disc pale brown; ascospores absent. PYCNIDIA laminal, conidia bacilliform to slightly bifusiform, 5–8 × ca. 1 µm.

COLOR REACTIONS: cortex K+ yellow, UV–; medulla K– or very pale yellowish, C–, KC–, P–, UV–.

CHEMISTRY: atranorin (major), chloroatranorin (minor), unknown fatty acid (minor).

> PARATYPE — Brazil, São Paulo State, Mogi-Guaçu Municipality, Reserva Biológica de Mogi-Guaçu, 22°22'S 46°56'W, 590 m alt., inside an orchard enclosure near cerradão and riparian woodland beside Goiabeiras stream, on twig of orchard tree, *M. P. Marcelli & M. Falco 33160*, 02-IV-1999 (SP).

COMMENTS– *Bulbothrix cassa* has flat sublaciniae to 3.0 mm wide, caducous isidia, and lacks taxonomically significant medullary substances (medulla spot tests negative). The non-bulbate rhizines arise from prominent veins, but there are a few bulbate rhizines growing directly from the lower cortex in very young portions of the thallus. The cilia are rarely contiguous and have a typically spherical bulb with a constricted base and a well-defined, short, acute, apex. Sometimes the bulbae become fused in the axils of the crenae. The paratype is a small thallus (probably juvenile), which has more abundant cilia with longer apices and a darker lower surface than the type.

Bulbothrix ventricosa (Hale & Kurok.) Hale is similar in morphology and habitat but differs in containing medullary norstictic acid and having characteristic black dots on the upper surface which are anatomically similar to ciliar bulbae (Benatti, pers. comm.).

Bulbothrix isidiza (Nyl.) Hale and *B. tabacina* (Mont. & Bosch) Hale also resemble *B. cassa* in growth habit. However, these two species contain salazinic acid in the medulla. Moreover, *B. isidiza* has a uniformly pale brown lower surface while *B. tabacina* has a jet-black lower surface and shorter conidia (<5 µm long in specimens from the same area).

Bulbothrix bulbochaeta (Hale) Hale, another species lacking diagnostic medullary substances (Hale & Kurokawa 1964, Divakar & Upreti 2005), differs from *B. cassa* in lacking isidia and in aspects of cilia and rhizine morphology.

The specific epithet derives from the Latin *cassa* (empty) in reference to the absence of taxonomically important medullary substances in this species.

Bulbothrix lacinulata Marcelli, Jungbluth & Elix, **sp. nov.** **Fig. 3**
MB 511167

DIAGNOSIS: *Sicut* Bulbothrix suffixa, *sed thallo fimbriato lacinulato et medulla reactionibus K+, P+ differt.*

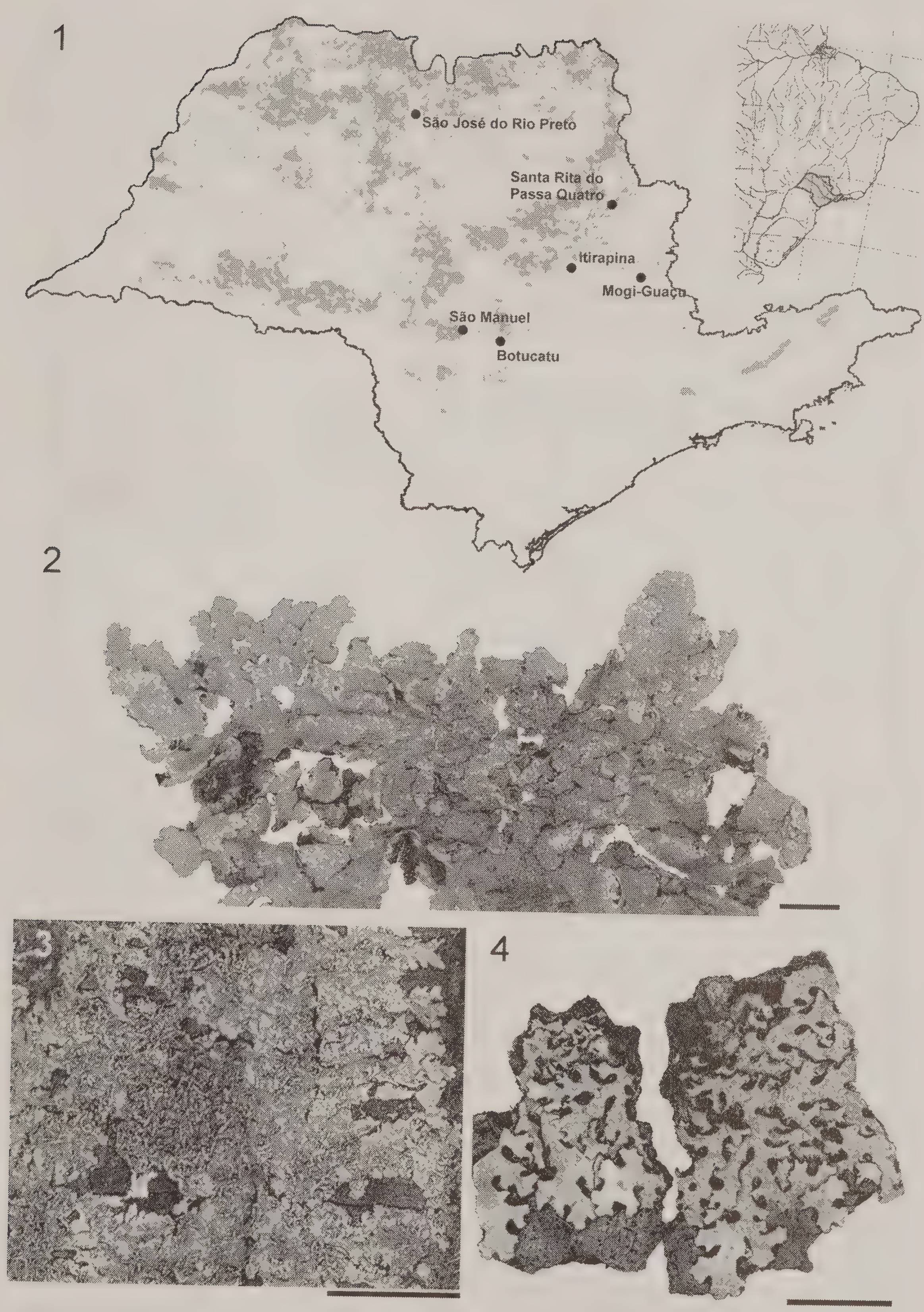
HOLOTYPUS – Brazil, São Paulo State, Itirapina Municipality, Estação Ecológica do Instituto Florestal, 22°15'S 47°49'W, 770 m alt., woodland, on a tree trunk, *L. S. Canêz, P. Jungbluth* & *A. A. Spielmann 1083A*, 27-III-2004 (SP).

THALLUS greenish-grey, shiny, corticolous, laciniate-lacinulate, adnate, 1.0–2.5 cm broad; laciniae irregularly to dichotomously branched, contiguous, 0.5–1.0 mm wide, apices truncate, margin crenate to crenulate or irregular; upper surface smooth, maculae weak and irregular, chiefly in the young parts, obscure due to the shiny surface; cilia black, bulbate, simple to furcate, 0.05–0.10 mm long, bulbae 0.01–0.05 mm diam., contiguous. PUSTULAE, SOREDIA and ISIDIA absent. LACINULAE chiefly marginal but covering the entire proximal surface, highly branched when fully developed, flat to subcanaliculate, apices truncate, 0.20–0.70 × 0.10–0.15 mm, lower surface pale brown, mainly with submarginal, ciliar bulbae with very poorly developed apices. MEDULLA white. LOWER SURFACE shiny, black, rugose; margin shiny, dark brown, 0.1–0.6 mm wide, rugose, papillate and bulbate, the color darkening towards the center, rhizinate to the margins; rhizines black or dark brown, simple or sometimes furcate, 0.10–0.15 mm long, abundant, evenly distributed. APOTHECIA absent. PYCNIDIA laminal, conidia filiform to weakly bifusiform, (5–) 6–8 × ca. 1 µm.

COLOR REACTIONS: cortex K+ yellow, UV–; medulla K+ faint yellow, C+ rose, KC+ rose, P+ yellow, UV–.

CHEMISTRY: cortical atranorin (minor) and chloroatranorin (minor); medullary gyrophoric acid (major) and lecanoric acid (minor).

PARATYPES — Brazil, São Paulo State, Itirapina Municipality, Estação Ecológica do Instituto Florestal, 22°15'S, 47°49'W, 770 m alt., woodland, on a tree trunk, *L. S. Canêz, P. Jungbluth* & *A. A. Spielmann 1083B-L*, 27-III-2004 (paratypes from the type collection: 1083B-J in SP; 1083K in NY; 1083L in H).


1
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São Manuel
Botucatu
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Figures 1-4. **1.** Localization of São Paulo State in southeastern South America, its remnants cerrados areas (gray) and the collected municipalities. **2.** *B. cassa* (part of the holotype). **3.** *B. lacinulata* (part of the holotype). **4.** *B. suffixa* (holotype).

Bars = 5 mm.

TABLE 1. Comparison of species of the *Bulbothrix fungicola* group based on Hale & Kurokawa 1964 (a), Hale 1976 (b), Lynge 1914 (c), Marcelli 1993 (d) and/or the type material (t).

	LOBES WIDTH (MM)	LOWER SURFACE	CILIA (MM)	VEGETATIVE PROPAGULES	APOTHECIA	ASCOSPORES (µM)	MEDULLARY ACIDS
B. fungicola	0.5–1.0 (c)	black to dark brown (c)	0.15–0.20 (d) 0.02–0.08 (–0.12) × 0.02–0.08 (–0.10) (t)	“isidioid” (t)	coronate (b)	8–10 × 4–6 (c)	gyrophoric (b)
B. goebelii	0.5–1.5 (b)	dark brown to black (b)	up to 1.5 (b) (0.04–) 0.08–0.12 (–0.28) × 0.02–0.04 (–0.08) (t)	isidia (b,t)	ecoronate (b)	8–10 × 4–6 (b)	gyrophoric (b)
B. lobarica	0.25–1.25 (t)	polish; black center, faint-brown margin (t)	0.10–0.30 × 0.05–0.10 (t)	isidia (t)	unknown	unknown	gyrophoric and lobaric (t)
B. apophysata	0.7–1.5 (a)	black center, broad pale brown near lobes tips (a)	0.2–0.3(–0.5) × 0.05 (d) (0.02–) 0.06–0.18 (–0.32) × (0.02–)0.04–0.06(–0.10) (t)	isidia (a,t)	ecoronate (d) holotypus sterile!	8–9 × 5.4 (d)	lobaric (b)
B. lacinulata	0.05–1.0 (t)	polish; black center, dark brown margin (t)	0.05–0.10 × 0.01–0.05 (t)	lacinules (t)	unknown	unknown	gyrophoric (t)
B. suffixa	0.5–1.5 (b)	black (b,t)	0.5–0.7 × 0.05–0.20 (d) 0.04–0.20 (–0.44) × 0.04–0.08 (–0.20) (t)	isidia (t)	coronate (b)	6–12 × 3–5 (b)	gyrophoric (b)

COMMENTS– *Bulbothrix lacinulata* is characterized by the laciniae with abundant, weakly canaliculate lacinules, the black lower surface with simple or furcate rhizinae and the presence of gyrophoric acid and lecanoric acid in the medulla. The K+, P+ reactions are probably due to low concentrations of atranorin and chloroatranorin in the medulla (K+ faint yellow, C+ rose, KC+ rose, P+ yellow).

The holotype of *B. suffixa* (Stirt.) Hale (BM!, Fig. 4), a very similar species, contains only gyrophoric acid in the medulla (K–, P–), has wider laciniae, longer cilia, shorter, flat lacinules (0.1–0.6 mm long) which are not abundant and are most likely adventitious formations which are known to be common in the genus (Marcelli 1993).

Given the abundant and regularly developed lacinules in some collections, at least part of the material cited by Hale (1976) and Marcelli (1993) as *B. suffixa* should be transferred to *B. lacinulata.*

Bulbothrix fungicola (Lynge) Hale produces isidia and very rarely may exhibit lacinules. However, these lacinules originate from adjacent thalli of *B. lacinulata* as previously discussed by Marcelli (1993, as *B. suffixa*).

This species, together with *B. apophysata* (Hale & Kurok.) Hale, *B. fungicola*, *B. goebelii* (Zenker) Hale, *B. lobarica* (see below), and *B. suffixa* forms a distinct group of species with narrow, delicate lacinulae and frequent to abundant cilia (Table 1, at left).

The specific epithet refers to the typical lacinulae of this species.

Bulbothrix lobarica Jungbluth, Marcelli & Elix, **sp. nov.** **Fig. 5**
MB 511168

DIAGNOSIS: *Sicut* Bulbothrix apophysata, *sed acidum gyrophoricum continenti differt.*

HOLOTYPUS– Brazil, São Paulo State, Itirapina Municipality, Estação Experimental do Instituto Florestal, 22°15'S 47°49'W, 770 m alt., along the trail inside cerradão next to Pedregulho, on a tree trunk, *L. S. Canêz, P. Jungbluth & A. A. Spielmann 1174*, 24-III-2004 (SP).

THALLUS greenish-grey, corticolous, laciniate, adnate, 1.5–2.0 cm wide; laciniae irregularly to dichotomously branched, contiguous, 0.25–1.25 mm wide, apices truncate; margin smooth to crenate; upper surface continuous, shiny, maculae absent; cilia with black bulbae, apices black to colorless, simple to often furcate or ramified, 0.10–0.30 mm long, bulbae 0.05–0.10 mm diam., contiguous along the entire margin. PUSTULAE and SOREDIA absent. ISIDIA laminal, simple or rarely irregularly branched, cylindrical, base highly constricted, 0.1–0.2 mm long, erect or procumbent, laminal, apices ±brown. MEDULLA white. LOWER SURFACE brown; margin shiny, pale brown, 0.1–1.0 mm wide, papillate and bulbate, the color darkening towards the center, rhizinate to the margin; rhizines with black bulbae, apices pale brown to colorless, densely, dichotomously branched and intricately interlaced to form a continuous tomentum, 0.10–0.25 mm long. Apothecia absent. Pycnidia laminal, conidia filiform to weakly bifusiform, 5–6 × ca. 1 µm.

Color reactions: cortex K+ yellow, UV–; medulla K–, C+ faint rose, KC+ rose, P–, UV+ faint blue.

Chemistry: atranorin (minor), chloroatranorin (minor), gyrophoric acid (major), and lobaric acid (minor).

Comments– *Bulbothrix lobarica* is characterized by the isidiate laciniae, the brown lower surface with dichotomously branched rhizines, and the presence of medullary gyrophoric and lobaric acids.

Morphologically, *B. lobarica* resembles *B. apophysata*, another species which contains lobaric acid but has a somewhat larger thallus and lacks gyrophoric acid.

Other species of similar size, including *B. fungicola*, *B. goebelii*, *B. suffixa* and *B. lacinulata*, do not produce lobaric acid (medulla UV–).

The specific epithet refers to the presence of lobaric acid in the medulla of this new species.

Bulbothrix regnelliana Jungbluth, Marcelli & Elix, **sp. nov.** **Fig. 6**
MB 511169

Diagnosis: *Sicut* Bulbothrix subcoronata, *sed lobis subtus brunneolis differt.*

Holotypus– Brazil, São Paulo State, São José do Rio Preto Municipality, 20°49'S, 49°22'W, 489 m alt., on palm tree trunk in open field, *D. F. Peralta 2325*, 09-IV- 2004 (SP, isotype in B).

Thallus greenish grey, corticolous, sublaciniate to lobate, somewhat ascending, 4.5–6.0 cm wide; lobes irregularly branched, commonly weakly canaliculate, imbricate to crowded, 1.5–2.5 mm wide on the base of the lobe, 1.5–4.5 mm maximum width, apices rounded and somewhat involute, margin irregularly crenate; upper surface continuous, smooth; maculae absent; cilia black, bulbate, without apices, bulbae globose to reniform, 0.10-0.30 mm wide × 0.05–0.20 mm long, frequent, mostly restrict to the axils. Pustulae, soredia and isidia absent. Medulla white, ±pale creamy yellow in some parts of the upper medulla. Lower surface pale brown or beige, darker in center (never black), dull, rugose; margin dull, rugose, with sparse to frequent, narrow bulbae, margin without rhizines, 0.5 mm wide; rhizines with narrow, black basal bulbae, the tips concolorous with the lower suface or ±white, simple, 0.2–0.5 mm long, abundant, evenly distributed. Apothecia concave then urceolate, incised and folded on ageing, 0.5–4.5 mm diam., sessile, laminal, irregularly coronate; amphithecia smooth; disc brown, imperforate; margin crenate to deeply crenate at the bulbae; epithecia 10 µm high; hymenium 35–40 µm high; subhymenium 45–50 µm high; ascospores spherical to ellipsoid, 8–12 × 4–8 μm, episporium 1 μm. PYCNIDIA submarginal and subapical; conidia bacilliform to weakly bifusiform, 6–9 × ca. 1 μm.

SPOT TESTS: cortex K+ yellow, UV–; medulla K+ yellow → orange, C–, KC –, P+ orange, UV–.

CHEMISTRY: traces of atranorin (cortex), norstictic acid (medulla) and four unknown substances (Rfs greater than 40 in solvent C).

COMMENTS– *Bulbothrix regnelliana* is characterized by the lack of vegetative propagules, the brown lower surface, ascospores 8–12 μm long and the presence of norstictic acid in the medulla .

This new species has been widely misidentified as *B. subcoronata* (Müll. Arg.) Hale, a much smaller species with a shiny, black lower surface (holotype, G!). We believe that the material mentioned in Hale's classic monograph (1976) is actually *B. regnelliana.*

Two somewhat similar new species from southern Brazil (Spielmann & Marcelli 2008, Marcelli & Canêz 2008), with a dark lower surface, ascospores longer than 12 μm and narrower cilia have also probably been misidentified as *B. subcoronata.*

The species is named after the Swedish doctor and botanist, A. F. Regnell, whose legacy made possible Malme's very important Regnellian expeditions to Brazil in 1892–94 and 1901–03 (Marcelli 1998).

Bulbothrix vainioi Jungbluth, Marcelli & Elix, **sp. nov.** **Fig. 7**
MB 511170

DIAGNOSIS: *Sicut* Bulbothrix sensibilis, *sed sporis majoribus et ciliis dissimilibus differt.*

HOLOTYPUS– Brazil, São Paulo State, Botucatu Municipality, beside the highway that connects the city to the highway Castello Branco (SP-280), km 3, private cerradão forest inside Fazenda Morro do Ouro, 22°53'S, 48°26'W, 804 m alt, on a tree trunk, *M. P. Marcelli & S. B. Barbosa 35696*, 4-VI-2003 (SP).

THALLUS greenish-grey, corticolous, lobate, adnate, 2.5–9.0 cm wide; lobes irregularly branched, contiguous to imbricate, 1.2–2.0 (–4.0) mm wide at the base of the lobes, 2.0–4.0 mm maximum width, apices rounded, margin crenate; upper surface continuous to irregularly cracked, smooth to rugose; maculae punctiform and very small, but distinct and abundant, laminal; cilia black, bulbate to sometimes subspherical, simple, 0.05–0.20 mm long, bulbae 0.05–0.10 mm diam., few to frequent, mostly restricted to the axils; often the bulbae become elongate at the base of the ramifications and become reniform in shape; sometimes several bulbae become adjoined to form an elongate structure with several (3–5) short (abortive?) ciliar apices. PUSTULAE, SOREDIA and ISIDIA absent. MEDULLA white. LOWER SURFACE dull, black, rugose, with a very slight color change approaching the dull, dark brown margin; margin

0.1–3.0 mm wide, papillate and bulbate; some lobes rhizinate to the margin and others with a rhizine free border up to 2.0 mm wide; rhizines black, simple to rarely furcate, 0.1–0.8 mm long, abundant, evenly distributed. Apothecia cupuliform, 1–6 mm diam., adnate to substipitate, laminal to submarginal, margin smooth, amphithecium punctiform maculate, smooth, disc brown, imperforate; epithecia 5–10 µm high; hymenium 30–50 µm high; subhymenium 20–40 µm thick; ascospores ellipsoid to ovoid, (10–)12–14(–16) × (–7) 8–10 µm, episporium 1.0 µm. Pycnidia laminal, conidia bacilliform to weakly bifusiform, 6–8 × ca. 1 µm.

Color reactions: cortex K+ yellow, UV–; medulla K+ yellow → red, C–, KC–, P+ yellow, UV–.

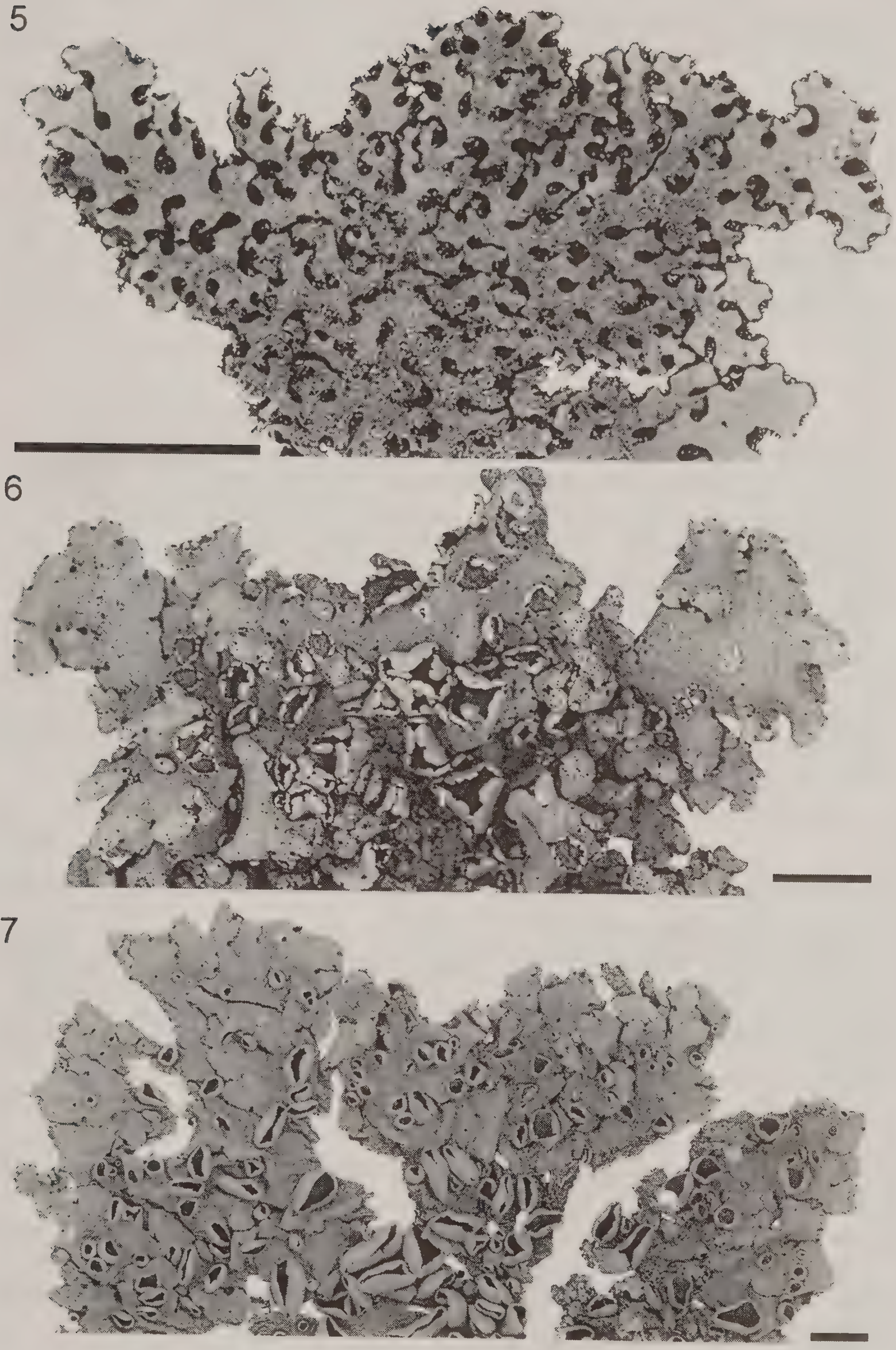
Chemistry: atranorin, consalazinic acid, salazinic acid and an unknown substance (Rf 34 in solvent C).

Paratypes — Brazil, São Paulo State, **Botucatu** Municipality, type locality, on a tree trunk,. *M. P. Marcelli & S. B. Barbosa 35693*, 4-VI-2003 (US); **Itirapina** Municipality, Estação Experimental do Instituto Florestal, 22°15'S, 47°49'W, 770 m alt., cerradão wood named Valério, on trunk of tree, border of the forest, *P. Jungbluth, L. S. Canêz & A. A. Spielmann 1137*, 25-III-2004; idem, cerradão wood named Limoeiro, on tree twig in the sunny footpath border, *P. Jungbluth, L. S. Canêz & A. A. Spielmann 881*, 26-III-2004; **Santa Rita do Passa Quatro** Municipality, Fazenda Vassununga, 21°43'S 47°29'W, 750 m alt., Anhanguera Road km 259, cerrado transition to cerradão, on tree trunk, *M. P. Marcelli & B. L. Morretes, 15653* (SP 158619), 3-VI-1978; **São Manuel** Municipality, Fazenda Palmeira da Serra, 22°48'S 47°29'W, 685 m alt., isolated 1 km diam. private cerradão wood reserve on hill top surrounded by pasture and cerrado sensu stricto with shrubs ca. 1-3 m height, *M. P. Marcelli & S. B. Barbosa 35232*, 3-VI-2003 (B).

Comments– *Bulbothrix vainioi* is a species that lacks vegetative propagules but has abundant, very small maculae, a black lower surface with a broad brown margin, relatively large ascospores (12–16 × 8–10 µm), and salazinic and consalazinic acids in the medulla. The reniform bulbae and elongate, inflated (or laterally expanded) basis from which multiple short ciliar apices emerge are often found at the base of the oval, lobes axils and are typical of this species.

Bulbothrix meizospora (Nyl.) Hale (lectotype, US!) differs by lacking maculae and in having cilia with larger bulbae and longer apices. The two other maculate *Bulbothrix* species, *B. hypocraea* (Vain.) Hale (lectotype, TUR-V!) and *B. linteolocarpa* Marcelli (holotype, SP!), have a pale brown lower surface and young cilia which are longer and with narrower bulbae.

Bulbothrix sensibilis (J. Steiner & Zahlbr.) Hale, originally described from Africa (Kenya), has imbricate, sublinear lobes (Hale 1976), indistinct cilia (Awasthi 1976) and ascospores 7.0–11.0 × 4.5–7.0 µm (Zahlbruckner 1926). The authors who studied the Indian (Awasthi 1976, Divakar & Upreti 2005) or African (Zahlbruckner 1926, Dodge 1959, Swinscow & Krog 1988) collections of *B. sensibilis* reported that the ascospores do not exceed 12 µm in length,



Figures 5-7. 5. *B. lobarica* (part of the holotype). 6. *B. regnelliana* (part of the holotype). 7. *B. vainioi* (part of the holotype).
Bars = 5 mm.

whereas Marcelli (1993), studying Brazilian material from cerrado forests, found ascospores 12.6–14.4 × 7.2–8.1 μm.

In his revisional monograph, Hale (1976) cited ascospores 7.0–18.0 × 5.0–12.0 μm for *B. sensibilis*. As he studied material from both South America (Venezuela) and Africa, we believe that two distinct taxa were involved in his circumscription: the Indian and African specimens with ascospores less than 12 μm in length corresponding to *B. sensibilis*, and the South American ones, with longer ascospores, now described as *B. vainioi*.

The specific epithet honors the Finnish lichenologist Edvard August Vainio [1853-1929], considered the father of Brazilian lichenology (Marcelli & Ahti 1998).

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Literature cited

Awasthi DD. 1976. Lichen genus *Parmelia* in India I – Subgenera *Parmelia* and *Amphigymnia*. Biological Memoirs, Lichenology Series 1: 155-229.

Bungartz F. 2001. Analysis of lichen substances. *In* http://gila.asu.edu/ViewCVS/ viewcvs.cgi/ *checkout*/asulichens/plb400/laboratory/chemistry/tlc.html. Accessed on December 2007.

Canêz LS. 2005. A família *Parmeliaceae* na localidade de Fazenda da Estrela, município de Vacaria, Rio Grande do Sul, Brasil. Mastership dissertation, Instituto de Botânica, São Paulo, 302 pp.

Coutinho LM. 1978. O conceito de cerrado. Revista Brasileira de Botânica 1: 17-23.

Coutinho LM. 2000. Aspectos do cerrado. *In* http://eco.ib.usp.br/cerrado/aspectos_clima.htm. Acessed on August 2007.

Divakar PK, Upreti DK. 2005. Parmelioid Lichens in India - a Revisionary Study. Bishen Singh Mahendra Pal Singh, India. 488 pp.

Dodge CW. 1959. Some lichens of Tropical Africa. III. *Parmeliaceae*. Annals of the Missouri Botanical Garden 46 (1-2): 39-193.

Elix JA. 1993. Progress in the generic delimitation of *Parmelia* sensu lato (Lichens, *Ascomycotina*: *Parmeliaceae*) and a synoptic key to the *Parmeliaceae*. The Bryologist 96: 359-383.

Elix JA. 1994. *Parmeliaceae*. Flora of Australia 55: 1-360.

Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. Bibliotheca Lichenologica 86: 1-7.

Farr ER, Hale BW, DePriest PT. 1999. *Parmeliaceae*: Searchable List of Names in the Parmelioid Genera (Lichens). *In* http://persoon.si.edu/parmeliaceae/. Accessed on October 1999.

Hale ME. 1976. A monograph of the lichen genus *Bulbothrix* Hale (*Parmeliaceae*). Smithsonian Contributions to Botany 32: 1-29.

Hale ME, Kurokawa S. 1964. Studies on *Parmelia* subgenus *Parmelia*. Contributions from the United States National Herbarium 36: 121-191.

Jungbluth P. 2006. A família *Parmeliaceae* (fungos liquenizados) em fragmentos de cerrados do Estado de São Paulo. Mastership dissertation, Instituto de Botânica, São Paulo, 323 pp.

Jungbluth P, Marcelli MP. 2006. Espécies de *Bulbothrix* (*Ascomycetes*, *Parmeliaceae*) isidiadas ou lacinuladas em cerrados do Estado de São Paulo, Brasil. Anais da Primeira Reunião Brasileira de Estudos Liquenológicos (1ª REBEL): 44-50.

Lynge B. 1914. Die Flechten der ersten Regnellschen Expedition. Die Gattungen *Pseudoparmelia* gen. nov. und *Parmelia* Ach. Arkiv för Botanik 13 (13): 1-172.

Marcelli MP. 1993. Pequenas *Parmelia* s. l. (Liquens: *Ascomycotina*) ciliadas dos cerrados brasileiros. Acta botanica brasilica 7: 25-70.

Marcelli MP. 1998. History and current knowledge of Brazilian Lichenology. *In*: Marcelli, MP & Seaward, MRD (Eds) Lichenology in Latin America: history, current knowledge and applications, p. 25-45. CETESB. São Paulo.

Marcelli MP. 2004. Checklist of lichens and lichenicolous fungi of Brazil. *In* http://www.biologie.uni-hamburg.de/checklists/lichens/south-america/brazil_l.htm. Accessed on January 2008.

Marcelli MP, Ahti T (Eds.) 1998. Recollecting Edvard August Vainio. CETESB. São Paulo. 179 pp.

Marcelli MP, Canêz LS. 2008. Novelties on Southern Brazilian *Parmeliaceae*. Mycotaxon. In prep.

Ratter JA, Ribeiro JF, Bridgewater WA. 1997. The Brazilian cerrado vegetation and threats to its biodiversity. Annals of Botany 80: 223-230.

Spielmann AA. 2005. A família *Parmeliaceae* (fungos liquenizados) nos barrancos e peraus da encosta da Serra Geral, Vale do Rio Pardo, Rio Grande do Sul, Brasil. Masters Dissertation, Instituto de Botânica, São Paulo, 204 pp.

Spielmann AA, Marcelli MP. 2008. *Bulbothrix viatica*, a new species of *Parmeliaceae* from Brazil. Mycotaxon 103: 201-205.

Swinscow TDV, Krog H. 1988. Macrolichens of East Africa. British Museum (Natural History), London. 390 pp.

Zahlbruckner A. 1926. Afrikanische Flechten (Lichenes). *In*: Engler, A (Ed.). Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflazengeographie. Band 60, p. 468-552. Verlag von Max Weg, Leipzig.

Zorzetto R, Fioravanti C, Ferroni M. 2003. A floresta renasce. Revista Pesquisa Fapesp 91: 48-53.

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Two new records of *Tuber* (*Pezizomycetes, Pezizales*) from China

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Abstract — Two truffle species, *Tuber excavatum* and *T. borchii* var. *sphaerospermum*, were collected and recorded for the first time in China. The morphology and distribution of each species is described and the relationship of related species is discussed.

Key words — *Ascomycota*, Southwestern China

Introduction

The truffle genus *Tuber* is abundant in southwestern China based on our extensive field investigation in the past four years. Eight *Tuber* species have been reported from this area (Tao & Liu 1989, Wang & Li 1991, Wang et al. 1998, Wang & He 2002, He et al. 2004, Chen et al. 2005a, b; Chen & Liu 2007). Recently, *Tuber excavatum* and *T. borchii* var. *sphaerospermum*, two new records from China, were collected in the course of surveys conducted in 2006 from local markets and *Pinus yunnanensis* forests respectively in southwestern China.

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In this paper, we illustrate these two species, comparing Chinese to European specimens, and note their relationship to other species.

Materials and methods

Notes on macroscopic characters were recorded from fresh specimens. Hand-cut sections of both fresh and dried ascomata were mounted on slides in 5% KOH for microscopic study. Line drawings were made with the oil immersion objective at 1000× with a Nikon E400 microscope and drawing tube. Spore, ascus and peridial cell measurements are given as length × width. Spore dimensions exclude ornamentation. Scanning electron photographs were taken with an AMRAY 1000B SEM following methodology presented by Chen & Liu (2007). Herbaria that provided specimens are abbreviated according to Index Herbariorum (Holmgren & Holmgren 2007) with one exception, HKAS Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences.

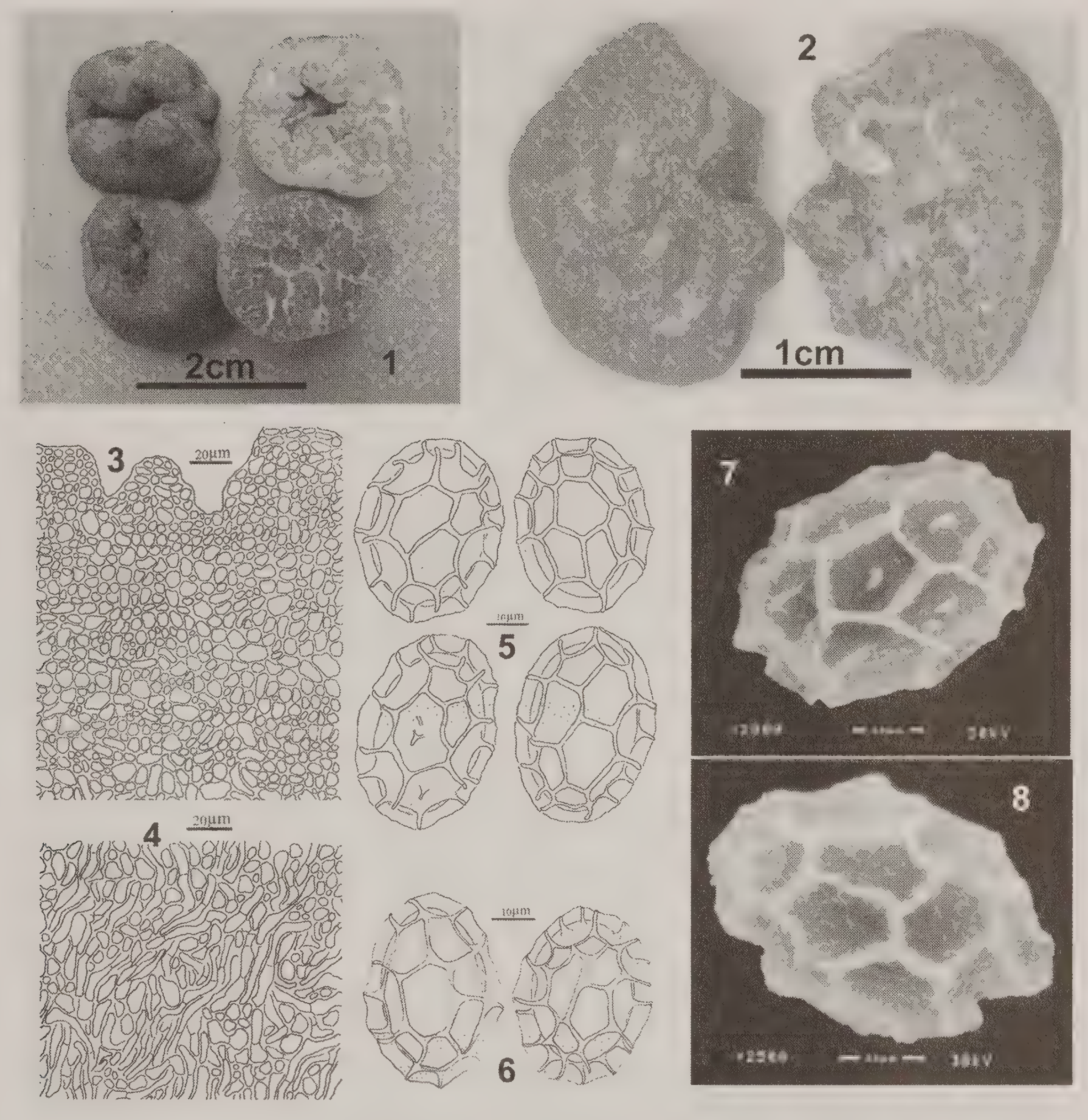
Taxonomy

Tuber excavatum Vittad., Monographia Tuberacearum p. 49, 1831. FIGS. 1-8.

ASCOMATA (FIGS. 1, 2) subglobose, 1.5–2 cm in diam, with a conspicuous cavity at the base; surface minutely papillose, yellow-brown to brown at maturity. PERIDIUM (FIGS. 3, 4) 200–500 µm thick (including warts 75–150 µm tall, 80–140 µm wide), composed of two layers: outer layer 100–300 µm thick, pseudoparenchymatous, composed of subglobose to ellipsoid, hyaline to pale yellow cells 6–15 × 5–11 µm with walls 1–3 µm thick; inner layer 150–300 µm thick, of hyaline, interwoven hyphae 3–5 µm in diam with walls thin to somewhat thickened. GLEBA firm, gray in youth and olive brown at maturity, marbled with off-white or cream-colored, radially arranged, branching veins which emerge through the peridium in the cavity.

ASCI globose, ellipsoid or irregular, sessile, with thin or slightly thickened walls, 80–110 × 65–90 µm, 1–4 (–5)-spored. ASCOSPORES (FIGS. 5-8) ellipsoid, yellow-brown to red-brown at maturity; spores in 1-spored asci 38–47 × 28–35 µm, in 2-spored asci 30–43 (–45) × (22–) 25–35 µm, in 3-spored asci 33–40 × 25–30 µm, in 4-spored asci 30–40 (–41) × (22–) 23–28 µm, in 5-spored asci 28–35 (–37) × 21–26 µm; Q (length/width ratio) = (1.2–) 1.25–1.60, **Q** (average of all ascospores sampled along with standard deviation) = 1.4 ± 0.10; ornamentation an alveolate reticulum 3–5 µm tall, the meshes 9–20 × 8–14 µm, 3–4 meshes across the spore width; spore walls 1–2 µm thick.

HABITAT: Hypogeous, usually in calcareous soil under species of *Betulaceae*, *Fagaceae*, *Salicaceae*, and *Pinaceae* (Ceruti et al. 2003). In southwestern China,



Figs. 1-8. *Tuber excavatum* Vittad. (1, 3-5, 7. HKAS52006; 2, 6, 8. K(M)123808)
1. Fresh ascomata; 2. Dry ascomata;
3. Pseudoparenchymatous tissue of outer layer of peridium;
4. Intricately interwoven hyphae of inner layer of peridium;
5,6. Line drawings of ascospores; 7,8. SEM of ascospores, showing the detail of ornamentation.

it occurs under *Pinus armandii* Franch. and *P. yunnanensis* Franch.; October through December at ca 2000 m elev., possibly ectomycorrhizal with *Pinus*.

Distribution: EUROPE: From 58° N. lat. to the Mediterranean coast, including England. AFRICA: Morocco (Ceruti et al. 2003). ASIA: China.

Specimens examined: **CHINA**: SICHUAN PROVINCE, Huidong county, local market, 3 Nov. 2006, Juan Chen & Yun Wang 411(HKAS52006). **ENGLAND**: West Cornwall, Penzance, Penlee Park, 1976, W. Cock, K(M)123811; Kent, Otford, 12 Aug. 1952, L. E. Hawker H619, K(M)123808; Gloucestershire, 26 Oct. 1953, L. E. Hawker H943, K(M)123809; Oxfordshire Oxford, Blenheim, 15 Sept. 1949, L. E. Hawker H21, K(M)123810.

REMARKS: *Tuber excavatum* was originally described from Italy (Vittadini 1831) and has been previously reported in Sichuan province, China (Wang 1990), but without listing vouchered specimens or providing a description. A thorough search of major Chinese herbaria (such as HKAS, HMAS and IFS) did not reveal any extant specimens.

Morphological features of Chinese and European specimens are identical and in accord with the description by Ceruti et al. (2003). Our molecular analysis supports the conspecificity of European and Chinese specimens. The specimens were found in a mixture of ascomata of *T. indicum* Cooke & Massee and *T. pseudoexcavatum* Y. Wang et al. in the local farmer's market of Huidong County, Sichuan province. This discovery of this species in China expands its known distribution and represents a broad European-Asian distribution pattern.

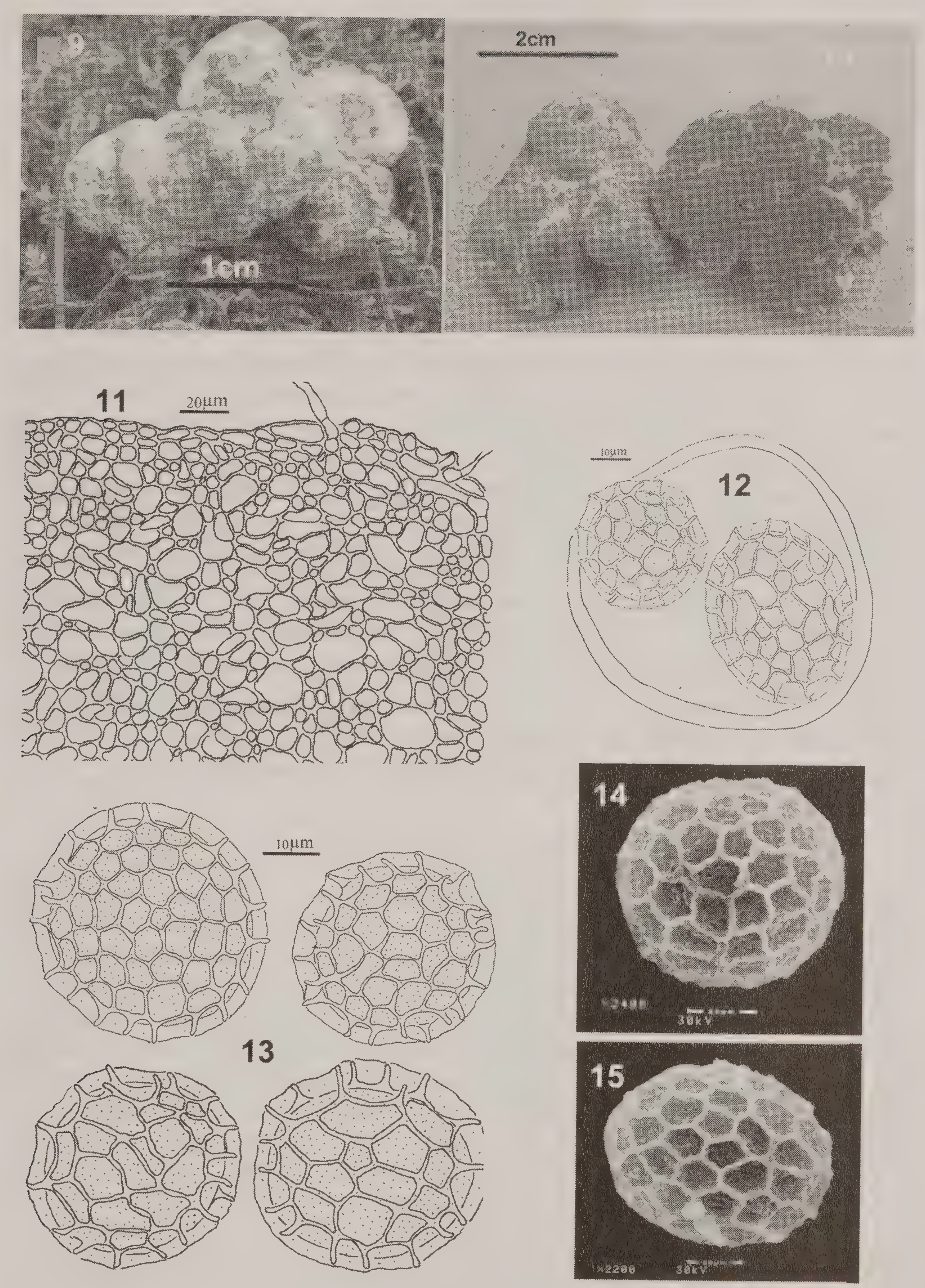
Tuber excavatum resembles *T. pseudoexcavatum* by its distinctive cavity and minutely verrucose peridial surface but is clearly distinguishable from the latter by having ellipsoidal spores with alveolate reticula. The spore ornamentation in *Tuber pseudoexcavatum* is spinose-reticulate, and the reticular walls are usually < 1 µm tall.

Tuber borchii* var. *sphaerospermum Malençon, Persoonia 7(2): 271, 1973. FIGS. 9-15.

ASCOMATA (FIGS. 9, 10) subglobose or irregular, 0.5–3.5 cm broad, more or less cracked and becoming pale pink at the gap edges, the surface conspicuously pubescent and furrowed, off-white with pale pink tones when fresh, becoming brown upon loss of pubescence. PERIDIUM (FIGS. 11) mostly 150–200 µm thick, composed of two layers: outer layer 60–100 µm thick, pseudoparenchymatous, of isodiametric to ellipsoid, hyaline to pale yellow cells 7–24 × 6–20 µm with walls 1–1.5 µm thick. Hyphal hairs abundant, arising from superficial cells 45–100 µm long, 4–6 µm broad at the base, tapered; inner layer 80–100 µm thick, of hyaline, thin-walled, interwoven hyphae 3–6 µm broad. GLEBA firm, gray in youth, olive brown to brown at maturity, marbled with off-white to cream-colored, thin veins.

ASCI (FIGS. 12) globose, ellipsoid or irregular, 65–90 × 45–70 µm, stalked in youth, sessile at maturity, 1–3 (–4)-spored. ASCOSPORES (FIGS. 13-15) globose to subglobose or broadly ellipsoid, yellow-brown at maturity; spores in 1-spored asci (25–) 28–40 (–43) × 25–38 (–40) µm, in 2-spored asci (23–) 25–35 × 23–32 µm, in 3-spored asci 23–32 (–34) × 23–32 µm, in 4-spored asci 20–27 × 20–27 µm, Q=1–1.11, **Q**=1.02±0.04; ornamentation an alveolate reticulum 2–4 µm tall, the mesh 5–13 × 4–13 µm, 4–6 meshes across the spore width; spore walls 2–3 µm thick.

HABITAT: Hypogeous, April-May, growing under *Pinus halepensis* Mill., *P. pinea* L. and *P. radiata* D. Don in Europe and Morocco (Malençon 1973, Ceruti


9
2cm
1cm
11
20μm
10μm
12
10μm
13
14
30kV
15
30kV

FIGS. 9-15. *Tuber borchii* var. *sphaerospermum* Malençon (HKAS52005)
9,10. Fresh ascomata;
11. Pseudoparenchymatous tissue of outer layer of peridium; 12. Asci;
13. Ascospores; 14,15. SEM of ascospores, showing the detail of ornamentation.

et al. 2003). In southwestern China found under *Pinus yunnanensis*, October, at ca 2300 m elev., possibly ectomycorrhizal with *Pinus*.

Distribution: EUROPE: From 40° N. lat. to the Mediterranean. AFRICA: Morocco (Ceruti et al. 2003). ASIA: China.

Specimens examined: CHINA: YUNNAN PROVINCE, Lijiang city, Yongsheng county, 29 Oct. 2006, Juan Chen & Yun Wang 404 (HKAS52005), Juan Chen & Yun Wang 405 (HKAS52014) and Juan Chen 406 (HKAS52013).

Remarks: *Tuber borchii* var. *sphaerospermum* was originally described from Morocco by Malençon (1973) has also been recorded in southern France, Spain and Morocco. It is characterized by white, pubescent ascomata, a pseudoparenchymatous peridium and globose ascospores with alveolate reticula. In 2006, more than 40 ascomata were collected in a 10m^2 "truffle burn" under *Pinus yunnanensis*. The morphological characters of our specimens are identical with the original description and that of Ceruti et al. (2003); unfortunately, we were unable to obtain and study the type. White or slightly pink ascomata with conspicuously pubescent and furrowed peridia and globose ascospores differentiate this species from other white *Tuber* species. It somewhat resembles *T. borchii* Vittad. and *T. maculatum* Vittad. when fresh, but the globose spores ($1 \leq Q < 1.05$) of *Tuber borchii* var. *sphaerospermum* differ from the ellipsoid spores ($Q \geq 1.3$) of the latter two. *Tuber borchii* var. *sphaerospermum* also resembles *T. oligospermum* (Tul. & C. Tul.) Trappe, which has globose ascospores, but the latter species has a prosenchymatous, not pseudoparenchymatous peridium.

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Literature cited

Ceruti A, Fontana, A, Nosenzo C. 2003. Le Specie Europee del Genere *Tuber*—Una Revisone Storica. Museo Reionale di Scienze Naturali, Torino. 467 pp.

Chen J, Liu PG, Wang Y. 2005a. Notes on *Tuber aestivum* Vittad. (*Tuberaceae, Ascomycota*) from China. Acta Botanica Yunnanica 27(4): 385–389.

Chen J, Liu PG, Wang Y. 2005b. *Tuber umbilicatum*, a new species from China, with a key to the spinose-reticulate spored *Tuber* species. Mycotaxon 94: 1–6.

Chen J, Liu PG. 2007. *Tuber latisporum* sp. nov. and its related taxa, based on morphology and DNA sequence data. Mycologia 99(3): 475–481.

He XY, Li HM, Wang Y. 2004. *Tuber zhongdianense* sp. nov. from China. Mycotaxon 90: 213–216.

Holmgren PK, Holmgren NH. 2007. Index Herbariorum. New York Botanical Garden. http://sciweb.nybg.org/science2/IndexHerbariorum.asp.

Malençon MG. 1973. Champignons hypogés du Nord de l'Afrique. 1: Ascomycètes. Persoonia 7: 261–288.

Riousset L, Riousset G, Chevalier G, Bardet MC. 2001. Truffes d' Europe et de Chine. Paris: Institut National de la Recherché Agronomique: 1–181.

Tao K, Liu B. 1989. A new species of the genus *Tuber* from China. Journal of Shanxi University (Natural Science Edition) 12: 215–218.

Wang B. 1995. Truffle resources of Sichuan. Edible Mushroom 6: 4 (in Chinese).

Wang Y, He XY. 2002. *Tuber huidongense* sp. nov. from China. Mycotaxon 83: 191–194.

Wang Y, Li ZP. 1991. A new species of the genus *Tuber* from China. Acta Mycologica Sinica 10: 263–265 (in Chinese).

Wang Y, Moreno G, Riousset LJ, Manjón JL, Riousset G, Fourré G, Massimo GD, García Montero LG, Díez J. 1998. *Tuber pseudoexcavatum* sp. nov., a new species from China commercialized in Spain, France and Italy with additional comments on Chinese truffles. Cryptogamie Mycologie 19: 113–120.

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Statistical analysis of morphological variability in a *Saprolegnia* isolate: taxonomic implications

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Abstract — Ten subcultures were derived from a single axenic base culture of *Saprolegnia* for testing to determine whether or not character state distributions of four taxonomically important sexual characters differed statistically from the base culture and from each other. Results revealed that eight of the eleven cultures differed significantly from at least one other with respect to two characters thus could be identified as different species.

Key words — watermold

Introduction

The worldwide distribution and ecological importance of the *Saprolegniaceae* (*Straminopila*, *Oomycota*), commonly referred to as watermolds, is well documented (see review by Johnson et al. 2002) although members of this diverse taxon remain difficult to identify at the species level. Of the 17 currently recognized watermold genera (Johnson et al. 2002), *Saprolegnia* is second only to *Achlya* in number of species and in difficulty of species identification (DP personal experience). Because of the importance of this genus, its taxonomic problems need resolution as soon as possible.

Hulvey et al. (2007) recently published an extensive study of *Saprolegnia* that provides important insight into its current taxonomic quagmire. Their data show a complete lack of congruency between species delineations based on gene sequence analysis and those based on traditional sexual morphology. Although data presented in their Table II call into question the validity of traditional sexual features as taxonomic characters, their Figure 2 suggests that certain morphological features may be unique to sequence-based species clades.

Further discontinuity between traditional taxonomy and gene sequence data in this genus is apparent in the recent paper by Dieguez-Uribeondo et al. (2007) in which members of the *S. diclina/parasitica* complex were found to belong to five phylogenetically different sequence clades.

We designed this study to further test the taxonomic validity of sexual characters in the genus *Saprolegnia*. To determine whether 4 sexual characters were sufficiently stable for use as taxonomic criteria in this genus, our null hypothesis was: Examination of subcultures derived from an axenic base culture by single spore or single hyphal tip isolation will produce statistically similar data sets.

Materials and methods

Our axenic *Saprolegnia* base culture, designated SAP 258, was recovered by single spore isolation from a soil sample collected in southeastern North Carolina and was among those investigated by Hulvey et al. (2007). We derived 10 subcultures from the SAP 258 base culture by standard single spore or single hyphal tip isolation protocols (Johnson 1956, Seymour 1970). We propagated 6 subcultures from single spores (SS1-SS6), 1 subculture (HTS) from a short (50 μm) hyphal tip, and a second (HTM) from a mid-length (80 μm) hyphal tip. The final 2 subcultures (HTL1 and HTL2) were derived from long hyphal tips (120 μm).

Stocks of base culture and all 10 subcultures were maintained on Difco Corn Meal Agar (CMA) at 22C in diffuse light with periodic transfer to fresh CMA until sexual characterization could be performed. Two cultures were subjected to morphological analysis per week until all eleven had been observed. Whereas sexual characters to be observed required culture propagation in water, sterile hemp seed halves (hs) were placed on the colony edge of CMA-grown cultures for 24 hours to allow infestation and then transferred (one hs per plate) to 15×100 mm Petri plates containing 20 mL of sterile distilled water. We prepared 5 replicate plates of each culture in this manner to ensure that we had sufficient mycelium for compiling the data described below. Preliminary experiments revealed that a 7-day incubation was optimal to permit maturation of all sexual features to be studied, thus all morphological characterizations were performed one week following transfer of hs to water. We severed the hyphal connection to the hs, mounted mycelia on a cleaned microscope slide, and observed features at 400× with Olympus phase contrast microscopes equipped with Image Pro® data analysis software.

It is important to note that replicate data sets were taken using mycelia grown in separate culture dishes by two well-experienced observers with frequent consultation to ensure accuracy of qualitative character data. We employed a blind verification protocol (described below) to eliminate observer bias, i.e. whenever one observer detected a questionable character state the second was asked to render an interpretation without knowing how the first had interpreted it. In every case throughout the study both observers rendered the same interpretation.

Each observer compiled $n=50$ observations for all of the 4 sexual characters (listed below) being studied. Derived data for a given character were pooled ($n=100$) before statistical analysis, but also were analyzed separately ($n=50$) to detect differences possibly attributable to observer subjectivity.

Preliminary observation revealed that the following character states were expressed by SAP 258 for the 3 qualitative characters we analyzed: (1) for antheridial origin we observed monoclinous, diclinous, and androgynous states, (2) for antheridial appression we found apical and lateral states only, and (3) for oospore centricity we found centric, subcentric type I and subcentric type II states. Illustrations of each of these characters and their possible character states can be found in Johnson (1956). The single quantitative character selected for study was oospore diameter, which was measured using the linear measurement feature of the ImagePro® software.

We compared all possible culture pairs to find the degree of divergence between pooled data sets ($n=100$) for each character and to test for differences in data recorded by the two observers. We use the χ^2 test to compare character state ratios for the three qualitative characters and Tukey's test to compare the mean oospore diameters. We set $P \leq 0.01$ as the level of statistical significance for the χ^2 test and ≥ 2.00 as significant for the Tukey's test.

Results

Oospore diameter was the least consistent morphological character with 19 (of 55) statistically significant differences between culture pairs for the pooled data sets (Table 1). This was followed by oospore centricity (11 differences), antheridial origin (5 differences), and antheridial appression (3 differences). Our most important finding, however, was that 8 of 11 cultures differed significantly from another culture with respect to two characters.

The validity of pooled data analyses depended on the accuracy of each observer's tallies. Table 2 presents results of statistical comparisons of observer data sets ($n=50$ for each observer). In 4 instances measurement of oospore diameter differed significantly between observers. Antheridial origin also differed in 3 instances, antheridial appression differed twice, and oospore centricity did not vary between observers.

Table 1: Statistically significant differences* between paired cultures for combined data sets (n=100). Blank cells indicate no difference. Duplicate differences not shown.

	SAP 258	SS 1	SS 2	SS 3	SS 4	SS 5	SS 6	HTL 1	HTL 2	HTM	HTS
SAP 258		OC				OD				OD	
SS 1											
SS 2		OC, OD									
SS 3		OC									
SS 4		OC									
SS 5		OD	OC	OD	AO, OD			OD	AA		
SS 6		AO,OC	OC			AA, OD			AO,OD	AO, OD	
HTL 1		OC									
HTL 2		OC	AA								
HTM		OD	OC	OD	OD			AO, OD	OD		
HTS		OD	OC	OD	OD			OD			

* χ^2 significance levels for paired cultures are set at $P \leq 0.01$ and are indicated by antheridial origin [AO], antheridial appression [AA], oospore centricity [OC]. Tukey's test significance level for oospore diameter [OD] is set at ≥ 2.00.

Table 2: Statistically significant differences* between individual observer data sets (n = 50 for each observer) for each culture and character. Blank cells indicate no difference.

	Culture										
	SAP 258	SS 1	SS 2	SS 3	SS 4	SS 5	SS6	HTL 1	HTL 2	HTM	HTS
Origin		<0.0001							<0.0001		<0.0006
Appression	0.0033					0.0001					
Centricity											
Diameter	3.8059	5.666					3.7143		3.7161		

* χ^2 significance levels for qualitative characters (antheridial origin, antheridial appression, and oospore centricity) are set at $P \leq 0.01$. Tukey's test significance level for oospore diameter is set at ≥ 2.00.

Discussion

The only precisely quantifiable character investigated in this study was oospore diameter. The fact that both observers measured oospores using the linear measurement feature of the ImagePro® software gave us a high degree of confidence in the accuracy of derived data. Nevertheless, we detected 4 statistically significant differences between observer data sets (Table 2) with respect to this character. Because of the precision of the Image Pro® software we suggest that these differences were not caused by bias, but rather reflected true differences resulting from measurements having been made from separate (although replicate) cultures propagated in different Petri dishes.

We believe, furthermore, that the blind test format used for gathering qualitative data precluded observer bias. In every instance where there was a question of character state interpretation accuracy, our blind test verification showed agreement between observers. We, thus, conclude that all differences between observer data sets (Table 2) for antheridial origin and antheridial appression were real differences due to observers having analyzed separate replicate cultures.

Substantial overlap exists between morphology-based species at least in the larger genera *Achlya*, *Saprolegnia*, and *Aphanomyces* (Johnson et al. 2002). Such overlap suggests that some sexual characters either are too plastic for valid taxonomic use or should be subordinated (Johnson 1956) to more stable ones. As the present investigation relates to this issue, we would point out that 8 of our 11 cultures differed from another by 2 morphological characters (Table 1) and, by classical taxonomic descriptions, could be considered different species even though they clearly were not.

We do not propose that analysis of a single organism, such as we have done, constitutes grounds for invalidating all historical taxonomic work on watermolds. We do believe, however, that other studies of this type must be undertaken to evaluate the magnitude of intraspecific morphological plasticity in *Saprolegnia* and other watermold genera before meaningful taxonomic revision can be made, perhaps primarily on the basis of sequence data.

Although we did not determine the cause of the plasticity we have documented, explaining it would be of academic if not taxonomic interest. In this regard we propose one variable – nuclear number – that might explain it. It has long been known (e.g. Coker 1923, Johnson 1956, Seymour 1970) that an undetermined number of nuclei pack into a watermold hyphal tip that is destined to become a particular sexual feature. If each nucleus contributes cumulatively to the ultimate expression of the tip, then character state might vary depending on the number of nuclei distal to the delimiting septum. We know of no precedent for such a phenomenon in mycological literature, but suggest that this possibility should be tested in *Saprolegnia* and other genera of the *Saprolegniaceae*. If nuclear number influences the morphology of watermold sexual features, it is apparent that these characters no longer can be relied upon and a comprehensive revision should be undertaken, at least within *Saprolegnia*, that defines new characters yielding a taxonomy consistent with gene-sequence-based phylogenies such as reported by Hulvey et al. (2007).

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Literature cited

Coker WC. 1923. The *Saprolegniaceae* with notes on other watermolds. Univ. North Carolina Press: Chapel Hill, 201 pp.

Diéguez-Uribeondo J, Fregenada-Grandes J, Cerenius L, Pérez-Iniesta, E, Aller-Gancedo JM, Tellaria MT, Söderhäll K, Martin MP. 2007. Reevaluation of the enigmatic species complex *Saprolegnia diclina-Saprolegnia parasitica* based on morphological, physiological, and molecular data. Fungal Genetics and Biology 44:585-601.

Hulvey JP, Padgett DE, Bailey JC. 2007. Species boundaries within *Saprolegnia* (*Saprolegniales*, *Oomycota*) based on morphological and DNA sequence data. Mycologia 99: 421-429.

Johnson Jr TW. 1956. The genus *Achlya*: morphology and taxonomy. Univ. Michigan Press: Ann Arbor, 180 pp.

Johnson Jr TW, Seymour RL, Padgett DE. 2002. Biology and systematics of the *Saprolegniaceae*. On-line publication accessible at <http://dl.uncw.edu/digilib/ biology/ fungi/taxonomy%20and%20systematics/padgett%20book/>

Seymour RL. 1970. The genus *Saprolegnia*. Nova Hedwigia (Beiheft) 19: 1-124.

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Twenty species of corticioid fungi newly recorded from China

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Abstract—Twenty species of corticioid fungi recorded from China for the first time include: *Aleurodiscus tsugae, Amethicium luteoincrustatum, Coniophora arida, Dendrothele alliacea, Dentipellis leptodon, Hyphoderma variolosum, Hyphodontia lanata, H. ovispora, H. poroideoefibulata, H. subglobosa, Hypochnicium erikssonii, Licrostroma subgiganteum, Lopharia ayresii, Phanerochaete carnosa, P. crassa, P. leptoderma, P. rubescens, P. tropica, Pseudolagarobasidium calcareum*, and *Scytinostroma odoratum*. Collections of these species were made from China during 2002–07. Sources of the modern description and line drawing are indicated for all these species.

Key words—*Homobasidiomycetes*, taxonomy, wood-decay

Introduction

Corticioid fungi are defined in this study as *Homobasidiomycetes* with predominately resupinate basidiocarps. Corticioid fungi consist of the large and heterogeneous family *Corticiaceae* s.l. (Donk 1964, Parmasto 1986) and other resupinate fungi belonging to other families in the *Homobasidiomycetes*. Resupinate genera traditionally regarded as polypores are not included in this study. Evidence derived from molecular studies has revealed that corticioid genera are distributed across all major clades of *Homobasidiomycetes* (Larsson et al. 2004, Binder et al. 2005), indicating that the corticioid fungi represent a polyphyletic group.

Early knowledge of corticioid fungi in China was contributed by S.C. Teng and S.H. Ou in papers published during 1934–39; these results were first compiled in Teng's (1939) book entitled "A contribution to our knowledge of the higher fungi of China" and later revised several decades later (Teng 1996). No corticioid fungi were surveyed in China between 1940–80, but several studies have been undertaken since. Yin's (1981) report of 42 species of resupinate *Aphyllophorales* new to China was based on his study of specimens deposited at herbarium of Microbiological Institute, Chinese Academy of Sciences

(HMAS). Hjortstam & Ryvarden (1988) reported 98 species in *Corticiaceae* s.l. from Changbaishan Forest Reserve in northeastern China, the majority of which were found to be new to China. Maekawa & Zang (1995) reported 77 corticioid species from Yunnan Province, 41 of which were new to mainland China. A further 113 corticioid species were reported from Sichuan Province by Maekawa et al. (2002), including 40 new records for mainland China. Finally, Wu (2002) reported 20 species of the corticioid fungi new to mainland China.

This paper presents 20 species of corticioid fungi newly recorded from China. Collections were made by the author, alone or with others, from the provinces of Yunnan (SW China), Hubei (C China), Jilin (NE China), and Guangdong (S China) during 2002–07. These specimens are deposited at herbarium of National Museum of Natural Science of ROC (TNM).

List of species and specimens

1. ***Aleurodiscus tsugae*** Yasuda, Mycol. Writ. 6: 1066 (1920)

> Specimen examined — China. Jilin: Fusong Hsian, Lushuihe, N 42.29, E 127.52, alt. 790 m, on trunk of *Pinus* sp., leg. S.H. Wu, Aug 19, 2007, *Wu 0708-16* (TNM F21358).

Distribution — Japan and eastern Russia (Núñez & Ryvarden 1997), and NE China (this study).

Remarks: *Aleurodiscus tsugae* was recorded from Japan and eastern Russia on *Pinus* spp. (Núñez & Ryvarden 1997), and its presence on a pine trunk in NE China was not unexpected. Núñez & Ryvarden (1997) provided description and line drawing of this species.

2. ***Amethicium luteoincrustatum*** Hjortstam & Ryvarden, Mycotaxon 25: 542 (1986)

> Specimens examined — China. Yunnan: Xishuangbanna, Menglun, the area of ex situ conservation for rare & endangered plants of southern Yunnan, alt. 550 m, 21.55 N, 101.16 E, on rotten trunk of angiosperm, leg. S.H. Wu & S.Z. Chen, Jun 18, 2006, *Wu 0606-48* (TNM F20444); Menglun, Menglun Tropical Botanical Garden, alt. 600 m, 21.56 N, 101.15 E, on rotten trunk of angiosperm, leg. S.H. Wu & S.Z. Chen, Jun 20, 2006, *Wu 0606-106* (TNM F20803).

Distribution — Argentina (Hjortstam & Ryvarden 1986), Taiwan (Wu 1990), and SW China (this study).

Remarks: *Amethicium luteoincrustatum* is evidently pantropical, although its distribution in many tropical countries has yet to be explored. Hjortstam (1995) erected new genus *Cericium* Hjortstam for this species, a genus that differs from *Amethicium* chiefly in having cystidia with yellowish incrustations. *Amethicium* is retained here for this species until the generic status of *Cericium* is supported by additional studies. See Wu (1990) for description and line drawing of this species.

3. ***Coniophora arida*** (Fr.) P. Karst., Not. Sällsk. Fauna et Fl. Fenn. Förh. 9: 370 (1868)

Specimen examined — China. Jilin: Antu Hsien, Erhtao Town, Changbaishan, Huansunpu, alt. 1,000 m, on rotten trunk, leg. S.H. Wu et al., Sep 6, 2004, *Wu 0409-198* (TNM F16981).

Distribution — Pantemperate, including NE China (this study).

Remarks: *Coniophora arida* is widely distributed throughout the northern temperate zone. This species resembles *C. puteana* (Schumach.) P. Karst., but differs from the latter by having tuberculate hymenial surface and brown instead of yellow-brown basidiospores. See Hallenberg (1985) for description and line drawing (the latter prepared by John Eriksson) of *C. arida*.

4. ***Dendrothele alliacea*** (Quél.) P.A. Lemke, Persoonia 3: 366 (1965)

Specimen examined — China. Hebei: Wulinshan, N 40.36, E 117.28, alt. 1,600 m, on trunk of angiosperm, leg. S.H. Wu & S.Z. Chen, Aug 28, 2003, *Wu 0308-9* (TNM F15232).

Distribution — Europe (Eriksson & Ryvarden 1975), North America (Ginns & Lefebvre 1993), and N China (this study).

Remarks: *Dendrothele alliacea* is closely related to *D. acerina* (Pers.) P.A. Lemke and differs from the latter by having wider basidiospores. *Dendrothele alliacea* was recorded from angiosperm trees of temperate Europe and North America. This is the first record of this species from Asia. See Eriksson & Ryvarden (1975) for description and line drawing of this species.

5. ***Dentipellis leptodon*** (Mont.) Maas Geest., Persoonia 7: 558 (1974)

Specimen examined — China. Jilin: Antu Hsien, Erhtao Town, Changbaishan, Tihsia Forest, N 42.05, E 128.05, alt. 1,600 m, on rotten wood, leg. S.H. Wu & S.Z. Chen, Sep 3, 2003, *Wu 0309-47* (TNM F15269).

Distribution — Australia, Canada, USA, Chile, India, and Japan (Ginns 1986), and NE China (this study).

Remarks: *Dentipellis leptodon* is not a common species but does have worldwide distribution. Studies concerning its geographic differentiation are needed to detect if any speciation exists. A comprehensive study and description of this species was presented by Ginns (1986).

6. ***Hyphoderma variolosum*** Boidin, Lanq. & Gilles, Bull. Trimest. Soc. Mycol. Fr. 107: 143 (1991)

Specimen examined — China. Yunnan: Xishuangbanna, Menglun, the area of ex situ conservation for rare & endangered plants of southern Yunnan, alt. 550 m, 21.55 N, 101.16 E, on branch of angiosperm, leg. S.H. Wu & S.Z. Chen, Jun 18, 2006, *Wu 0606-49* (TNM F20445).

Distribution — Central African Republic and Gabon (Boidin et al. 1991), tropical Taiwan (Wu 1997b), and SW China (this study).

Remarks: Within *Hyphoderma*, *H. variolosum* is distinct in having brown subicular hyphae and homothallic sexuality (Wu 1997b). Boidin et al. (1991) published the description, line drawing, and cultural studies of this tropical species.

7. ***Hyphodontia lanata*** Burds. & Nakasone, Mycologia 73: 461 (1981)

> Specimen examined — China. Yunnan: Xishuangbanna, Mengla Xian, Mengyuan, Nangonshan Nature Reserve, alt. 1,180 m, 21.38 N, 101.27, on branch of angiosperm, E, coll. S.H. Wu & S.Z. Chen, Jun 19, 2006, *Wu 0606-69* (TNM F20462).

Distribution — USA (Burdsall & Nakasone 1981), Brazil (Hjortstam & Bononi 1987), New Zealand (Cunningham 1959), Nepal (Hjortstam 1984), Taiwan (Wu 1990), and SW China (this study).

Remarks: *Hyphodontia lanata* is a subtropical species with worldwide distribution. One interesting feature of this species is the presence of sterile hyphal pegs in young basidiocarps. Wu (1990) provides a full description and line drawing of this species.

8. ***Hyphodontia ovispora*** (Corner) T. Hatt., Mycoscience 44: 271 (2003)

> Specimen examined — China. Yunnan: Xishuangbanna, Jinghong, Jinuoxiang, Longpa, Xiaola High Way 37 k, alt. 1,230 m; 21.59 N, 101.05 E, on branch of angiosperm, leg. S.H. Wu & S.Z. Chen, Jun 18, 2006, Wu *0606-28* (TNM F20426).

Distribution — Singapore (Hattori 2003), Taiwan (Wu 2000a, as *H. tropica* Sheng H. Wu), and SW China (this study).

Remarks: Hattori (2003) found that *Tyromyces ovisporus* Corner represents a *Hyphodontia* species with poroid hymenial surface, and proposed new combination (*H. ovispora*) for it. He also found that *H. tropica* is conspecific and that this taxon was nomenclaturally invalid because the holotype was not indicated in the original description (Wu 2000a). See Wu (2000a) for description and line drawing of this species under the name *H. tropica*.

9. ***Hyphodontia poroideoefibulata*** Sheng H. Wu, Mycologia 93: 1021 (2001)

> Specimens examined — China. Hubei: Wuhan, Huazhong Agricultural University, Lion Mt., alt. 70 m, 30.29 N, 114.20 E, on rotten trunk, leg. S.H. Wu & S.Z. Chen, Jun 24, 2006, *Wu 0606-137* (TNM F20830); 30.29 N, 114.21 E, on rotten root, leg. S.H. Wu & S.Z. Chen, Jun 29, 2006, *Wu 0606-230* (TNM F20912).

Distribution — Taiwan (Wu 2001) and C China (this study).

Remarks: *H. poroideoefibulata* is distinct among *Hyphodontia* species in having simple-septate hyphae with poroid hymenial surface. See Wu (2001) for description and line drawing of this species.

10. ***Hyphodontia subglobosa*** Sheng H. Wu, Acta Bot. Fennica 142: 106 (1990)

Specimen examined — China. Yunnan: Xishuangbanna, Green Stone Forest Park, 620 m; 21.55 N, 101.16 E, on branch of angiosperm, leg. S.H. Wu & S.Z. Chen, Jun 19, 2006, *Wu 0606-87* (TNM F20478).

Distribution — Taiwan (1990) and SW China (this study).

Remarks: Among *Hyphodontia* J. Erikss., *H. subglobosa* is distinct in having simple-septate generative hyphae and tubular cystidia. See Wu (1990) for description and line drawing.

11. ***Hypochnicium erikssonii*** Hallenb. & Hjortstam, Windahlia 18: 44 (1990)

Specimen examined — China. Liaoning: Shenyang, Beilin Park, alt. 50 m, on stump, leg. S.H. Wu et al., Sep. 4, 2004, *Wu 0409-39* (TNM F16945).

Distribution — USA (Ginns & Lefebvre 1993), Europe (Eriksson & Ryvarden 1976), Japan (Maekawa 1994), and NE China (this study).

Remarks: *Hypochnicium erikssonii* was earlier known as *Hypochnicium sphaerosporum* (Höhn. & Litsch.) J. Erikss. Hallenberg & Hjortstam (1990) proposed a new species, *H. erikssonii,* when they determined that type specimen of *Peniophora sphaerospora* Höhn. & Litsch. was conspecific with *H. punctulatum* (Cooke) J. Erikss. See Eriksson & Ryvarden (1976, as *H. sphaerosporum* and Maekawa (1994, as *H. sphaerosporum*) for description and line drawing of this species. Hallenberg & Hjortstam (1990) provided description and culture study for this species.

12. ***Licrostroma subgiganteum*** (Berk.) P.A. Lemke, Can. J. Bot. 42: 763 (1964)

Specimens examined — China. Yunnan: Chinlunghsia, alt. 1,850 m, N 25.04, E 102.22, on branch of angiosperm, leg. S.H. Wu, Nov. 7, 2002, *Wu 0211-21* (TNM F14721); on trunk of angiosperm, *0211-22* (TNM F14722).

Distribution — North America (Ginns & Lefebvre 1993), and SW China (this study).

Remarks: The stereoid basidiocarps, the presence of SA+ gloeocystidia, and large basidia and basidiospores of this species resemble those found in of *Aleurodiscus* s.l; however, the monotypic genus *Licrostroma* was erected to accommodate the inamyloid, smooth basidiospores of *L. subgiganteum;* its phylogenetic placement has not yet been studied. See Lemke (1964) for description and line drawing of this species.

13. ***Lopharia ayresii*** (Berk. ex Cooke) Hjortstam, Mycotaxon 54: 188 (1995)

Specimen examined — China. Yunnan: Mengla Hsien, Menglung, Manmo Village, Rain Forest Valley Forest Park, N 21.54, E 101.10, alt. 630 m, on branch of angiosperm, leg. S.H. Wu, Apr 14, 2005, *Wu 0504-3* (TNM F18713).

Distribution — Central African Republic and Réunion (Boidin & Gilles 1991), Taiwan (Wu 1990), and SW China (this study).

Remarks: *Lopharia ayresii* greatly resembles *L. mirabilis* (Berk. & Broome) Pat. but differs in having merulioid instead of smooth hymenial surfaces. See Wu (1990, as *Hyphoderma macrosporum*) for a full description and line drawing.

14. ***Phanerochaete carnosa*** Burt (Parmasto), Eesti NSV Tead. Akad. Toim., Biol. seer 16: 388 (1967)

Specimen examined — China. Guandong: Guanzhou, Tianlujiaoye Park, alt. 130 m, 23.14 N, 113.24 E, on branch of angiosperm, leg. S.H. Wu, July 1, 2006, *Wu 0607-10* (TNM F20930).

Distribution — Pantemperate (Burdsall 1985), Brazil (Hjortstam & Larsson 1994), Taiwan (Wu 1997a), and S China (this study).

Remarks: Burdsall (1985) noted that distribution of *P. carnosa* is apparently circumpolar in north temperate and boreal habitats, but since then this species has also been reported from some subtropical regions (Brazil, Taiwan and S China). Further study is needed to determine whether different species with similar morphological characters are currently included under this name. See Eriksson et al. (1978) and Burdsall (1985) for descriptions and line drawings.

15. ***Phanerochaete crassa*** (Lév.) Burds., Mycol. Mem. 10: 67 (1985)

Specimens examined — China. Yunnan: Ximeng, Mengsuo, Longtan, N 22.39, E 99.35, alt. 1,150 m, on rotten branch of angiosperm, leg. S.H. Wu, Apr. 15, 2005, *Wu 0504-22* (TNM F18719), *-25* (TNM F18694), *-27* (TNM F18695).

Distribution — Pantropical (Hjortstam & Larsson 1994).

Remarks: *Phanerochaete crassa* is also known under the names of *Lopharia crassa* (Lév.) Boidin, *Porostereum crassum* (Lév.) Hjortstam & Ryvarden, and *Hjortstamia crassa* (Lév.) Boidin & Gilles (Boidin & Gilles 2003). This species is regarded herein as belonging to *Phanerochaete* in the broad sense. See Hjortstam & Ryvarden (1990) and Wu (1992) for descriptions and line drawings.

16. ***Phanerochaete leptoderma*** Sheng H. Wu, Acta Bot. Fennica 142: 45 (1990)

Specimen examined — China. Yunnan: Ximeng, Mengsuo, Longtan N 22.39 , E 99.35, alt. 1,150 m, on branch of angiosperm, leg. S.H. Wu, Apr. 15, 2005, *Wu 0504-21* (TNM).

Distribution — Taiwan (Wu 1990), Japan (Maekawa 1997), and SW China (this study).

Remarks: *Phanerochaete leptoderma* is closely related to *P. angustocystidiata* Sheng H. Wu, which, however, bears a distinct basal layer and narrower basidiospores. See Wu (1990) for a full description and line drawing.

17. ***Phanerochaete rubescens*** Sheng H. Wu, Mycol. Res. 102: 1131 (1998)

Specimen examined — China. Guandong: Guanzhou, Tianlujiaoye Park, alt. 130 m, 23.14 N, 113.24 E, on stump of angiosperm, leg. S.H. Wu, July 1, 2006, *Wu 0607-6* (TNM F20926).

Distribution — Taiwan (Wu 1998) and S China (this study).

Remarks: *Phanerochaete rubescens* is diagnosed by a basidiocarp with marginal cordons and red color-change of the hymenial surface in KOH. See Wu (1998) for a full description and line drawing of this species.

18. ***Phanerochaete tropica*** (Sheng H. Wu) Hjortstam, Mycotaxon 54: 189 (1995)

Specimens examined — China. Yunnan: Wenshanchou, Wenshan, Hsihuashan, alt. 1,400 m, N 23.22, E 104.14, on branch of angiosperm, leg. S.H. Wu, Nov. 1, 2002, Wu 0211-35(TNM F14699), -36 (TNM F14700).

Distribution — Taiwan (Wu 1990, as *Efibula tropica*) and SW China (this study).

Remarks: *Phanerochaete tropica* is separated from *P. pallidovirens* (Bourdot & Galzin) Hjortstam by its larger basidiospores. See Wu (1990), as *Efibula tropica*) for a full description and line drawing.

19. ***Pseudolagarobasidium calcareum*** (Cooke & Massee) Sheng H. Wu, Acta Bot. Fennica 142: 112 (1990)

Specimen examined — China. Guandong: Guanzhou, Tianlujiaoye Park, alt. 130 m, 23.14 N, 113.24 E, on branch of living angiosperm, leg. S.H. Wu, July 1, 2006, *Wu 0607-12* (TNM F20932).

Distribution — Australia (Cooke 1892), Malaysia and Sierra Leone (Reid 1956), Taiwan (Wu 1990), Japan (Maekawa & Hasebe 2002), and S China (this study).

Remarks: Conspecificity of *P. calcareum* and *P. subvinosum* needs to be investigated (Wu 2000b, Maekawa & Hasebe 2002). The collection from Guandong province of China is presently referred to *P. calcareum*, due to its comparatively smaller basidiospores. See Wu (1990) and Maekawa & Hasebe (2002) for descriptions and line drawings.

20. ***Scytinostroma odoratum*** (Fr.) Donk, Fungus, Wageningen 26: 20 (1956)

Specimen examined — China. Jilin: Antu Hsien, Erhtao Town, Changbaishan, Tihsia Forest, N 42.05, E 128.05, alt. 1600 m, on rotten trunk, leg. S.H. Wu & S.Z. Chen, Sep 3, 2003, *Wu 0309-56* (TNM F15277).

Distribution — Pantemperate, including NE China (this study).

Remarks: Among other representatives of *Scytinostroma* Donk, *S. odoratum* resembles *S. ochroleucum* in having inamyloid basidiospores and simple-septate generative hyphae but differs from the latter in having smaller basidiospores. See Hallenberg (1985) for description and line drawing (the latter prepared by John Eriksson).

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Literature cited

Binder M, Hibbett DS, Larsson KH, Larsson E, Langer E, Langer G. 2005. The phylogenetic distribution of resupinate forms across the major clades of mushroom-forming fungi (*Homobasidiomycetes*). Systematics and Biodiversity 3: 113–157.

Boidin J, Gilles G. 1991. *Basidiomycètes Aphyllophorales* de l'île de la Réunion XVI. Les genres *Hyphoderma, Hyphodermopsis, Chrysoderma* nov. gen. et *Crustoderma*. Cryptog. Mycol. 12: 97–132.

Boidin J, Gilles G. 2003. À propos du genre *Lopharia* sensu lato (*Basidiomycètes, Aphyllophorales*). Bull. Soc. Mycol. France 118: 91-115.

Boidin J, Lanquetin P, Gilles G. 1991. Les *Peniophoraceae* de la zone intertropicale (*Basidiomycetes, Aphyllophorales*). A. Especes paleotropicales. Bull. Soc. Mycol. France 107: 91–147.

Burdsall HH. 1985. A contribution to the taxonomy of the genus *Phanerochaete* (*Corticiaceae, Aphyllophorales*). Mycol. Mem. 10: 1-165.

Burdsall HH, Nakasone KK. 1981. New or little known lignicolous *Aphyllophorales* (*Basidiomycotina*) from southeastern United States. Mycologia 73: 454–476.

Cooke MC. 1892. Australian fungi, supplement to handbook. Grevillea 21: 35–39.

Cunningham GH. 1959. The genus *Odontia* of New Zealand. Trans. Roy. Soc. New Zealand 86: 65–103.

Donk MA. 1964. A conspectus of the families of *Aphyllophorales*. Persoonia 3:199–324.

Eriksson J, Hjortstam K, Ryvarden L. 1978. The *Corticiaceae* of North Europe 5. *Mycoaciella–Phanerochaete*. Pp.889–1047. Fungiflora, Oslo.

Eriksson J, Ryvarden L. 1975. The *Corticiaceae* of North Europe 3. *Coronicium–Hyphoderma*. Pp. 285–546. Fungiflora, Oslo.

Eriksson J, Ryvarden L. 1976. The *Corticiaceae* of North Europe 4. *Hyphodermella–Mycoacia*. Pp. 547–886. Fungiflora, Oslo.

Ginns J. 1986. The genus *Dentipellis* (Hericiaceae). Windahlia 16: 35–45.

Ginns J, Lefebvre MNL. 1993. Lignicolous corticioid fungi (*Basidiomycota*) of North America. Mycol. Mem. 19:1–247.

Hallenberg N. 1985. The *Lachnocladiaceae* and *Coniophoraceae* of North Europe. Fungiflora, Oslo. 96 pp.

Hallenberg N, Hjortstam K. 1990. *Hypochnicium erikssonii* sp. nov. instead of *H. sphaerosporum* – a necessary name alternation. Windahlia 18: 43–46.

Hattori T. 2003. Type studies of the polypores described by E.J.H. Corner from Asia and West Pacific Areas. V. Species described in *Tyromyces* (2). Mycoscience 44: 265–276.

Hjortstam K. 1984. Some new and noteworthy *Basidiomycetes* (*Aphyllophorales*) from Nepal. Mycotaxon 20: 133–151.

Hjortstam K. 1995. Two new genera and some new combinations of corticioid fungi (*Basidiomycotina*, *Aphyllophorales*) from tropical and subtropical areas. Mycotaxon 54: 183–193.

Hjortstam K, Bononi VLR. 1987. A contribution to the knowledge of *Corticiaceae* s.l. (*Aphyllophorales*) in Brazil. Mycotaxon 28: 1–15.

Hjortstam K, Larsson KH. 1994. Annotated check-list to genera and species of corticioid fungi (*Aphyllophorales*, *Basidiomycotina*) with special regards to tropical and subtropical areas. Windahlia 21: 1–75.

Hjortstam K, Ryvarden L. 1986. Some new and noteworthy fungi (*Aphyllophorales*, *Basidiomycetes*) from Iguazu, Argentina. Mycotaxon 25: 539–567.

Hjortstam K, Ryvarden L. 1988. Notes on the *Corticiaceae* of northern China. Acta Mycol. Sinica 7: 77–88.

Hjortstam K, Ryvarden L. 1990. *Lopharia* and *Porostereum* (Corticiaceae). Synop. Fung. 4: 1–68.

Larsson KH, Larsson E, Kõljalg U. 2004. High phylogenetic diversity among corticioid homobasidiomycetes. Mycol. Res. 108: 983–1002.

Lemke PA. 1964. The genus *Aleurodiscus* s.l. in North America. Canad. J. Bot. 42: 723–768.

Maekawa N. 1994. Taxonomic study of Japanese *Corticiaceae* (Aphyllophorales) II. Rept. Tottori Mycol. Inst. 32: 1–123.

Maekawa N. 1997. Taxonomic study of Japanese *Corticiaceae* (Aphyllophorales) III. Rept. Tottori Mycol. Inst. 35: 29–38.

Maekawa N, Hasebe K. 2002. *Pseudolagarobasidium calcareum*: Japanese records and cultural characteristics. 43: 271–275.

Maekawa N, Yang ZL, Zang M. 2002. Corticiaceous fungi (*Aphyllophorales*, *Basidiomycotina*) collected in Sichuan province, China. Mycotaxon: 81–95.

Maekawa N, Zang M. 1995. Corticiaceous fungi (*Aphyllophorales*, *Basidiomycotina*) collected in Yunnan, China. Bull. Natn. Sci. Mus., Tokyo, Ser. B, 21: 87-94.

Núñez M, Ryvarden L. 1997. The genus *Aleurodiscus* (*Basidiomycotina*). Synop. Fung. 12: 1–164.

Parmasto E. 1986. On the origin of the *Hymenomycetes* (what are corticioid fungi?). Windahlia 16:3–19.

Reid D. 1956. New or interesting records of Australasian *Basidiomycetes*. Kew Bull. 10: 631–648.

Teng SC. 1939. A contribution to our knowledge of the higher fungi of China. Natl. Inst. of Zoo. & Bot, Acad. Sin. Press, 614 pp.

Teng SC. 1996. Fungi of China. Mycotaxon Press. Ithaca, 586 pp.

Wu SH. 1990. The *Corticiaceae* (*Basidiomycetes*) subfamilies *Phlebioideae*, *Phanerochaetoideae* and *Hyphodermoideae* in Taiwan. Acta Bot. Fennica 142: 1-123.

Wu SH. 1992. Notes on rsupinate *Basidiomycetes* of Taiwan II. Two new record *Porostereum* species. Bull. Natl. Mus. Natu. Sci. 3: 267–271.

Wu SH. 1997a. Notes on resupinate *Basidiomycetes* of Taiwan IV. Fung. Sci. 12: 9–13.

Wu SH. 1997b. New species and new records of *Hyphoderma* (*Basidiomycotina*) from Taiwan. Bot. Bull. Acad. Sin. 38: 63–72.

Wu SH. 1998. Nine new species of *Phanerochaete* from Taiwan. Mycol. Res. 102: 1126–1132.

Wu SH. 2000a. Studies on *Schizopora flavipora* s.1., with special emphasis on specimens from Taiwan. Mycotaxon 76: 51–66.

Wu SH. 2000b. Survey of the *Corticiaceae* in Taiwan, to 2000. Fung. Sci. 15: 69–80.

Wu SH. 2001. Three new species of *Hyphodontia* with poroid hymenial surface. Mycologia 93: 1019–1025.

Wu SH. 2002. New records of the *Corticiaceae* from mainland China. Mycotaxon 82: 289–294.

Yin JZ. 1981. A preliminary study on the resupinate *Aphyllophorales* from China. Acta Bot. Yunnanica 2: 241–274.

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A re-description of *Xylaria phosphorea*

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Abstract — *Xylaria phosphorea*, originally described from Australia, is a species rarely reported in the mycological literature. A collection from Sri Lanka is therefore used to reassess its morphology compared to the type material and one of its synonyms. The *Xylaria* presented here is characterised by an orange-brown stromatal surface, mammiform perithecial outlines with distinct papillate to conical black ostioles and reddish-brown fusiform ascospores. The present paper serves to re-describe this species in detail, to summarise information about it and to illustrate it in colour.

Key words — ascomycetes, pyrenomycetes, taxonomy

Introduction

Unlike the majority of perithecial ascomycetes, the type genus of the *Xylariaceae* Tul. & C. Tul., *Xylaria* Hill ex Schrank, typically forms large upright stromata that are frequently collected, even by people other than mycologists. Stromata vary from long filiform to sessile with few superficial perithecia to stout cylindrical or globose with numerous perithecia entirely immersed. Numerous species have been described, but the genus has never been monographed. Rogers (1986) produced a key to North American species, and other relatively recent studies of more or less restricted areas have been published, e.g. Congo (Dennis 1961), New Zealand (Rogers & Samuels 1986), Papua New Guinea (Dennis 1974, Van der Gucht 1994, 1996), North Sulawesi (Rogers et al. 1987), Mexico (San Martín & Rogers 1989, San Martín et al. 1999), South America (Dennis 1956, 1957), Venezuela (Rogers et al. 1988), or Taiwan (Ju & Rogers 1999). Tropical and subtropical areas are particularly rich in species of this genus. Most species occur on wood, some on herbaceous stems, some on fruits, a few spring from unknown substrates in the soil, or from roots or are associated with underground termitaria. The present paper re-describes *X. phosphorea*, a rare species with a distinctive set of morphological features.

Methods

Pigment solubility was examined in 10 % KOH. For microscopic measurements preparations were mounted in 5 % KOH, viewed and photographed with a Zeiss Axio Imager A.1. Morphological structures were also examined and photographed after mounting in water, Lugol solution or 3% KOH on a compound microscope using Nomarski differential interference contrast, a Nikon DS-U2 digital camera and NIS-Elements D2.20 software. Stromatal colour was determined according to Kornerup & Wanscher (1981).

Taxonomy

Xylaria phosphorea Berk., J. Linn. Soc., Bot. 13: 177 (1872). FIGS. 1, 2

≡ *Xylosphaera phosphorea* (Berk.) Dennis, Kew Bull. 13(1): 105 (1958).
= *Xylaria rhizophila* Cooke & Massee, Grevillea 22: 37 (1893).
= *Xylaria riograndensis* Theiss., Ann. Mycol. 6: 343 (1908).

MACROCHARACTERS — Stromata (Fig. 1 a-c) solitary or gregarious, fasciculate or not, 6-43 mm long, 2-8 (mostly < 5) mm wide; fertile part 5-33 mm long, fusiform, cylindrical, compressed or not; cross section circular, ellipsoid or oblong; surface smooth, with strongly projecting mammiform perithecial mounds (Fig. 1 d-f), rust brown (6-7E6-8), colour resulting from a thin (ca 20 µm) smooth orange- to reddish-brown crust and black projecting papillate to conical ostioles, ca 100-300 µm long, (65-)90-145(-168) µm (n=50) diam, measured at the surface. Stromatal apex obtuse and fertile or acute and sterile and then longitudinally striate, concolorous. Stipe 5-30 mm long and 1-3 mm wide, comprising 1/5 to 2/3 of entire stromatal length, cylindrical, finely longitudinally striate and concolorous with the crust of the fertile part, extended in some stromata by a radicating part, that is nearly black and partly covered with sulphur yellow to rust mycelium. Consistency medium hard, entostroma massive, white, fibrous to cheesy. No pigments dissolved in KOH (10%).

MICROCHARACTERS — Perithecia (Fig. 2 a) (0.3-)0.35-0.55(-0.75) mm (n=30) high and wide, globose, densely disposed, peridium black, ca 20 µm wide. Paraphyses ca 2-4 µm wide. Asci (Fig. 2 b) (90-)104-127(-132) µm long, (5-)5.7-6.8(-7.4) µm (n=34) wide, spore part (67-)85-104(-112) µm long, stipe (7-)13-30(-36) µm long, cylindrical, containing 8 uniseriate ascospores; apical apparatus (Fig. 2 d) short, funnel- to inverted hat-shaped, amyloid, (1.2-)1.4-1.8(-2.1) µm high, (2-)2.2-2.6(-2.8) µm (n=50) wide, refractive in KOH and water. Ascospores (Fig. 2 c, e, f) fusiform, often inequilateral, bright reddish brown in water and lactic acid, dark brown in KOH, smooth, ends narrowly rounded, (11-)12-13.7(-14.5) × (4-)4.5-5.5(-6.3) µm, av. 12.8 × 5 µm, l/w = (2-)2.3-3 (n=90), containing 1-3 guttules, germ slits on the ventral side, straight (Fig. 2 c, e, f), parallel to ascospore axis, length varying from 50 to 95 % of ascospore length.

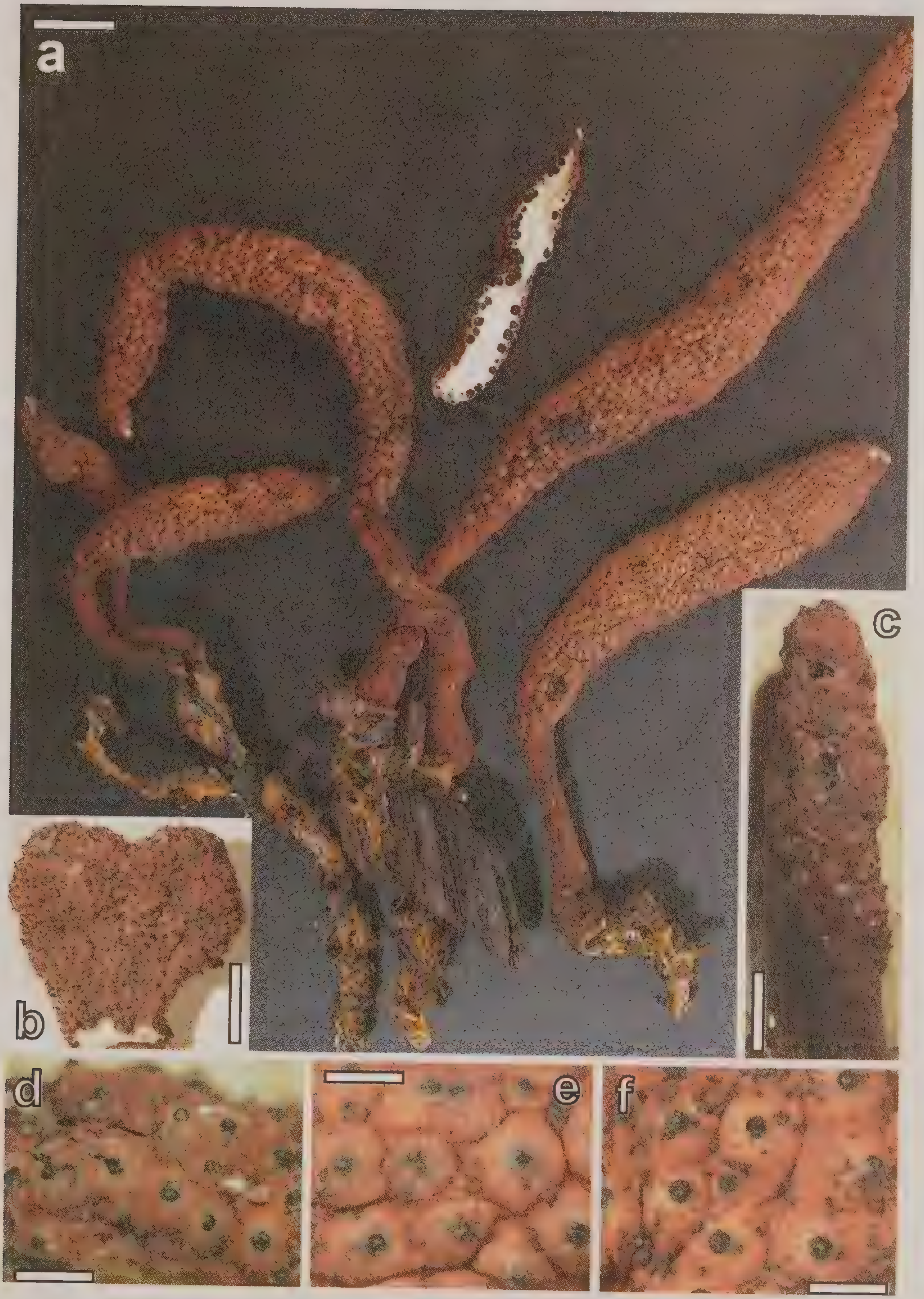

Fig. 1. *Xylaria phosphorea*. Stromata. a, WU 26104, b, fertile part of *X. rhizophila*, K 130085. c, holotype K 57347 of *X. phosphorea*, d-f, mammiform perithecial mounds, d, K 57347, e, WU 26104, f, K 130085. Scale bars: a = 4 mm, b = 3 mm, c = 1.4 mm, d = 0.5 mm, e, f = 0.4 mm.

HABITAT — on the ground, on woody plant debris, reported also from grass roots in (sub-)tropical regions.

DISTRIBUTION — rarely collected but widespread, probably pantropical; reported from Australia, Brazil, Cuba, India, Mexico, Sri Lanka, and Venezuela.

> SPECIMENS EXAMINED — SRI LANKA. Mountain rain forest just above Hakgala Sanctuary Botanical Gardens, ca. 1900 m s.m. (ca. 6 km SE of Nuwara Eliya), on the ground, rooting stipes incorporating wood chips, 12.II.1984, I. Krisai-Greilhuber 2368 (WU 26104). AUSTRALIA. Victoria, F. von Müller (K 57347, holotype of *X. phosphorea*). Brisbane, L. H. Bailey (syntypes K 130085 and K 146190 of *X. rhizophila*).

Discussion

The synonymy given above is solely based on morphology. The following characters are used to suggest conspecificity: projecting and mammiform perithecia, prominent black papillate to conical ostioles, orange- to reddish-brown crust, concolorous and longitudinally furrowed part of the stipe just below the fertile part of the stromata, size and shape of the ascal plug, size, shape, colour and germ slits of ascospores.

However, there are some differences between the specimens examined, that deserve comments: In the holotype of *X. phosphorea*, that grew on wood, stromata are minute, 6-10 × 2-3 mm, slightly more reddish-brown than the other specimens (possibly due to conservation measures), with stout, longitudinally furrowed stipes but no radicating part and no sterile tips. In the syntype K 130085 of *X. rhizophila* stromata are fasciculate (up to 4) on long radicating stipes to 2/3 of total length (most broken off and lost), partly covered by yellow mycelium; fertile parts are short and broad, laterally compressed and only 2–3 mm wide, some laterally fused, without sterile apices. The stromata of the syntype K 146190 are fusiform to clavate, circular to only slightly compressed in cross section, stipe furrowed, with little or no yellow mycelium. It is unclear why two syntypes exist, given the fact that only one specimen (Bailey 1007) is cited in the protologue. In any case, it may be interesting to note that germ slits in the majority of ascospores from a single perithecium of K 130085 were found to make up ca. 80 % the ascospore length, with only a small fraction showing germ slits ca. 6-7 µm long, i.e. ca. 50-60 % of ascospore length. The same situation was found in the holotype of *X. phosphorea*. In contrast, K 146190 and our collection from Sri Lanka exhibited germ slits making up 50–75 % of ascospore length in the majority of ascospores and only a small fraction exhibited germ-slits of ca. 80-95 %. Our specimen from Sri Lanka fits best to syntype K 146190 in fertile parts, and best to K 130085 in the long radicating stipes. It contains the largest stromata of the specimens examined.

The size of ascospores of *X. rhizophila* is given too small in the protologue (8-10 × 2-3 µm; Cooke 1893), which was already noted by Lloyd (1920), and by

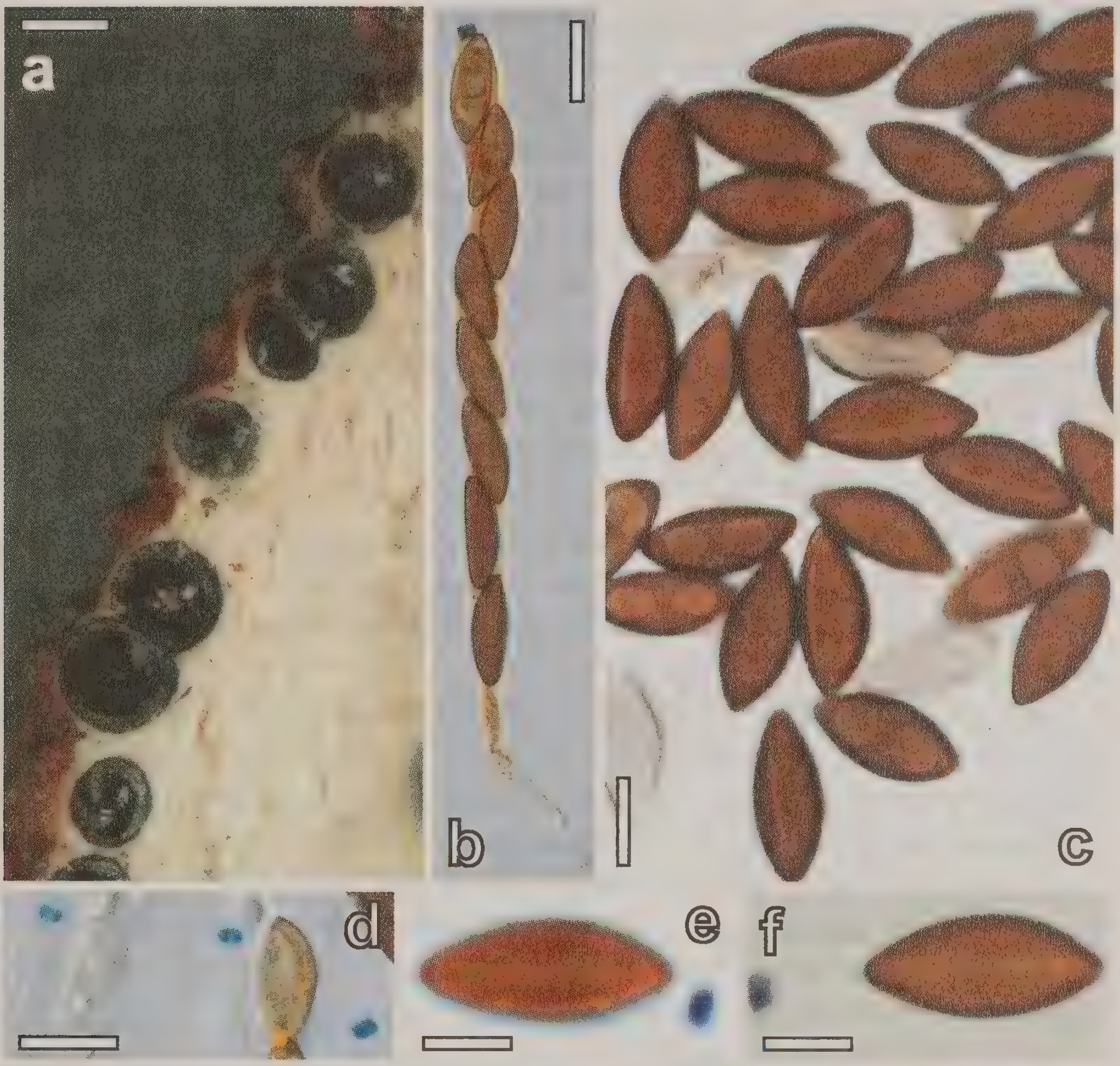

Fig. 2. *Xylaria phosphorea.* Perithecia, asci, ascospores. a, Peritheica and entostroma (WU 26104), b, ascus in Lugol (WU 26104), c, ascospores showing germ slits (in KOH, WU 26104), d, apical rings of asci in Lugol, e, ascospore with short germ slit (in Lugol, K 130085), f, ascospore with long germ slit (in Lugol, K 130085). Scale bars: a = 0.4 mm, b,d = 10 μm, c = 7 μm, e, f = 5 μm.

Martin (1970) when he combined this species in *Podosordaria* due to the light coloured, non-carbonized, covering of the stromata.

Another name to be considered here is *X. riograndensis*, described from Petropolis, Rio Grande do Sul in Brazil (Theissen 1908). It was not examined in this study, but the protologue describing e.g. the orange stromatal colour, mammiform perithecia and ascospore size (11-15 × 4-5 μm) as well as the illustration of fusiform stromata with acute sterile apices strongly suggest conspecificity with *X. phosphorea*. This was already concluded by Dennis (1956) upon examination of an isotype (S).

It may be argued that the information presently available is not sufficient to synonymise the taxa discussed above. On the other hand the differences described above are not convincing to separate them. Climatic conditions of all collection sites given above are comparable and give no clue about possible taxonomic differences. Differences in substrates may be hints to suggest separation of *X. phosphorea* and *X. rhizophila*: the former is described from wood, the latter from grass roots. However, observation and documentation of this character is often incorrect or unreliable. Unfortunately, it is not even clear, what the actual substrate of the specimen from Sri Lanka was. It grew apparently on wood debris buried in the ground. The primary substrate seems to be wood buried in the ground. The type and the specimen from Venezuela are reported from wood. Also *X. riograndensis* was described from wood. The Cuban specimen is described from a sheath of the palm genus *Roystonea* (Recio Herrera 1981).

Only future experiments, based on cultures, anamorphs and/or gene sequences can solve this question unequivocally. So far no useful information concerning an anamorph has been found in the literature or on the stromata examined.

The morphologically most closely related species is *X. fulvella* Berk. & M.A. Curtis (Berkeley 1868), differing from *X. phosphorea* only in smaller ascospores and was therefore retained as a separate species by Dennis (1956). The specimens K 146191, K 146192 and K 146193 were examined. They are apparently parts of the same collection (from Cuba, leg. C. Wright, No. 788) and consist of totally immature stromata devoid of perithecia and therefore do not permit any taxonomic conclusions. *X. fulvella* is thus only known from the type collection from Alabama, U.S.A.

Other taxa to be compared with *X. phosphorea* due to morphological similarities: Lloyd (1920) compared the smaller spored North American *X. graminicola* W. R. Gerard with *X. rhizophila*. Lloyd (1923) compared *X. phosphorea* to his *X. timorensis* Lloyd, but regarded it as a distinct species, although he based it on completely immature material. From descriptions the following species seem to be similar to *X. phosphorea*: the smaller-spored *X. guepinii* (Fr.) Ces. (Læssøe 1993), described from Italy, France, Brazil, Sri Lanka and Borneo on (manured) soil; the somewhat smaller-spored *X. bulbosa* (Pers.) Berk. & Broome from needle beds in Northern Europe (Læssøe 1992); the leaf inhabiting *X. phyllocharis* Mont. with less pronounced perithecial outlines (Dennis 1956) from Cayenne, French Guyana; and the soil inhabiting *X. xanthorrhiza* Pat. (Saccardo 1895) from Ecuador.

Xylaria phosphorea seems to be a rare species, but perhaps it is overlooked due to its small stromata and its habitat on the ground. Apart from the specimens mentioned above, which were all collected in the late 19th and early 20th centuries, only four more recent reports of this species were found: two collections from Kilbury and Kalika, India, on a stump and on buried angiosperm twigs (Thind & Dargan 1975; stromata brown, no orange or reddish colour mentioned); one collection in Tamaulipas, Mexico (San Martín & Rogers 1995); one specimen collected in Cuba (La Habana, Boyeros; Calabazar, on *Roystonea regia* (sheath), leg. H. Kreisel, 31 Jan 1969; published by Recio Herrera 1981, cf. Camino Vilaró et al. 2006); and one in Venezuela (Amazonas, Río Negro departamento, Cerro de la Neblina, Pico Phelps, on wood, leg. A.Y. Rossman, 22 Feb 1985; cf. Iturriaga & Minter 2006). The Venezuelan collection has a spore size of 17.5-22 × 6.5-7.5 µm and was therefore considered as a possible large-spored variety of *X. phosphorea* by Rogers et al. (1988; as *Xylaria* sp. R2264). Sri Lanka is a new collection site for this remarkable species.

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The curator of the mycological herbarium of Kew, B. Aguirre-Hudson, is acknowledged for the loan of type specimens. Special gratitude is due to Thomas Læssøe for many suggestions and critical reviews, Jack Rogers and Shaun Pennycook for presubmission and nomenclatural review of the paper. Thanks are also due to David Minter (CABI) who provided updated information on recent collections of *X. phosphorea.*

Literature cited

Berkeley MA. 1868. On a collection of Fungi from Cuba. Part. II, including those belonging to the families Gasteromycetes, Coniomycetes, Hyphomycetes, Physomycetes, and Ascomycetes. Journal Linnean Society, Botany 10: 341-392..

Camino Vilaró M, Mena Portales J, Minter DW. 2006. Fungi of Cuba. www.cybertruffle.org.uk/cubafung [website, version 1.00].

Cooke MC. 1893. Australian Fungi. Grevillea 22: 36-38.

Dennis RWG. 1956. Some Xylarias of tropical America. Kew Bulletin 11: 401-444.

Dennis RWG. 1957. Further notes on tropical American *Xylariaceae*. Kew Bulletin 12: 297-332.

Dennis RWG. 1961. *Xylarioideae* and *Thamnomycetoideae* of Congo. Bulletin Jardin Botanique Etat Bruxelles 31: 109-157

Dennis RWG. 1974. *Xylariaceae* from Papua and New Guinea. Bulletin Mensuel Société Linnéenne Lyon 43(num. spéc.): 127-138.

Iturriaga T, Minter DW. 2006. Fungi of Venezuela. www.cybertruffle.org.uk/venefung [website, version 1.00].

Ju Y-M, Rogers JD.1999. The *Xylariaceae* of Taiwan (excluding *Anthostomella*). Mycotaxon 73: 343-440.

Kornerup A, Wanscher JH.1981. Taschenlexikon der Farben. Muster-Schmidt Verlag: Zürich-Göttingen.

Læssøe T. 1992. *Xylaria digitata*: delimitation and typification I. Persoonia 14(4): 603-613.

Læssøe T. 1993. *Xylaria digitata*: delimitation and typification, part 2. Persoonia 15(2): 149-153.

Lloyd CG. 1920. *Xylaria rhizophila* and *Xylaria graminicola*. In: Mycological Notes 62. Mycological Writings 6: 936 + figs. 1713 & 1714.

Lloyd CG. 1923. Notes on *Xylaria*. Mycological Writings 7: 1246-1256.

Martin P. 1970. Studies in the *Xylariaceae* VIII. *Xylaria* and its allies. Journal of South African Botany 36: 73-137.

Recio Herrera G. 1981. Contribución al estudio de la familia *Xylariaceae* en Cuba. I. Revista del Jardín Botánico Nacional, Universidad de la Habana 2(2): 69-78.

Rogers JD. 1986. Provisional keys to *Xylaria* species in continental United States. Mycotaxon 26 (1): 85-97.

Rogers JD, Samuels GJ. 1986. Ascomycetes of New Zealand 8. *Xylaria*. New Zealand Journal Botany 24: 615-650.

Rogers JD, Callan BE, Samuels GJ. 1987. The *Xylariaceae* of the rain forests of North Sulawesi (Indonesia). Mycotaxon 29: 113-172.

Rogers JD, Callan BE, Rossman AY, Samuels GJ. 1988. *Xylaria (Sphaeriales, Xylariaceae)* from Cerro de la Neblina, Venezuela. Mycotaxon 31: 103-153.

Saccardo PA. 1895. Pyrenomyceteae. Sylloge Fungorum 11: 252-390.

San Martín F, Rogers JD. 1989. A preliminary account of *Xylaria* of Mexico. Mycotaxon 34: 283-373.

San Martín F, Rogers JD. 1995. Notas sobre la historia y relaciones de hospedante y distribución del género *Xylaria (Pyrenomycetes, Sphaeriales)* en México. Acta Botanica Mexicana 30: 21-40.

San Martín F, Lavín P, Pérez-Silva E, Esqueda-Valle M. 1999. New records of *Xylariaceae* of Sonora, México. Mycotaxon 71: 129-134.

Theissen F. 1908. Novitates Riograndenses. Annales Mycologici 6 (4): 341-352.

Thind KS, Dargan JS. 1975. *Xylariaceae* of India II. J. Indian bot. Soc. 53: 167-175.

Van der Gucht K. 1994. *Xylariaceae* in Papua New Guinea – identification keys. Science in New Guinea 20 (2-3): 85-98.

Van der Gucht K. 1996. *Xylaria* species from Papua New Guinea: cultural and anamorphic studies. Mycotaxon 60: 327-360.

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Skeletocutis luteolus sp. nov. from southern and eastern China

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Abstract — A new resupinate polypore, *Skeletocutis luteolus*, is described from southern and eastern China. It is characterized by the resupinate basidiocarps, buff-yellow coloured pore surface upon drying, dimitic hyphal structure with encrusted dissepiment edge, fusoid cystidioles, very narrow and allantoid basidiospores. The new species may be confused with *Skeletocutis nivea* and *S. fimbriata* by having similar narrow basidiospores, but *S. nivea* has effused-reflexed basidiocarps and smaller pores, while *S. fimbriata* has distinct rhizomorph and larger pores.

Key words — lignicolous and poroid fungi, taxonomy

Introduction

Skeletocutis Kotl. & Pouzar is a cosmopolitan genus, and most species in the genus have been found from the Northern Hemisphere. Taxonomy of the genus is difficult because of the tiny basidiospores observed in this genus do not provide many characters or show much variance among different species. A comprehensive study on the resupinate *Skeletocutis* was made by Niemelä (1998), and the knowledge of the genus in China was summerized by Dai (1998). During the survey of lignicolous fungi in China, one specimen from Wanmulin Nature Reserve, Fujian Province of eastern China and three specimens from Wuzhishan Nature Reserve, Hainan Province of southern China fitting the genus *Skeletocutis* were collected that have resupinate basidiocarps, small pores, dimitic hyphal structure with clamp connections on generative hyphae, finely encrusted hyphae in the dissepiment edge, fusoid cystidioles, and allantoid basidiospores. As there is no suitable existing name for specimens with these characters, we propose a new species described below.

Materials and methods

The studied specimens are deposited at the Herbarium of the Institute of Applied Ecology, Chinese Academy of Sciences (IFP) and the Herbarium of Beijing Forestry University (BJFC). Collections were examined with a microscope, and measurements and drawings were made from slide preparations stained with Cotton Blue or Melzer's reagent. The microscopic routine used in the study is as presented by Dai & Cui (2006). Spores were measured from sections cut from the tubes. IKI = for Melzer's reagent, KOH = 5% potassium hydroxide, and CB = Cotton Blue. CB– = acyanophilous, IKI– = both inamyloid and indextrinoid. In presenting the variation in the size of the spores, 5% of the measurements were excluded from each end of the range, and are given in parentheses. In the text the following abbreviations are used: L = mean spore length (arithmetical average of all spores), W = mean spore width (arithmetical average of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the average spore length and the average spore width), n = number of spores measured from given number of specimens. The width of a basidium was measured at the thickest part, and the length was measured from the apex (sterigmata excluded) to the basal septum. Sections were studied at magnification up to ×1250 by using a Nikon Eclipse E600 microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Special colour terms followed Petersen (1996) and Anonymous (1969).

Description

Skeletocutis luteolus B.K. Cui & Y.C. Dai, **sp. nov.** **Fig.1**

MycoBank MB 511494

Carpophorum annuum, resupinatum; facies pororum cremea vel bubalina; pori rotundi vel angulati, 5–7 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae sleletales subiculi 2.6–5 µm in diam. Sporae allantoideae, hyalinae, IKI–, CB–, 2.9–3.5 × 0.5–0.8 µm.

Type. — **China.** Hainan Prov., Wuzhishan County, Wuzhishan Nature Reserve, on rotten angiosperm wood, 25.XI.2007 Yang 796 (holotype in IFP, isotype in BJFC and H).

Etymology — *Luteolus* (Lat.): yellowish or buff yellow, referring to the pore surface of dried basidiocarp.

Fruitbody — Basidiocarps annual, resupinate, soft, without odour or taste when fresh, becoming corky hard upon drying; ca. 7 cm or more in longest dimension, 3 cm or more in widest dimension, and 0.3 cm thick. Pore

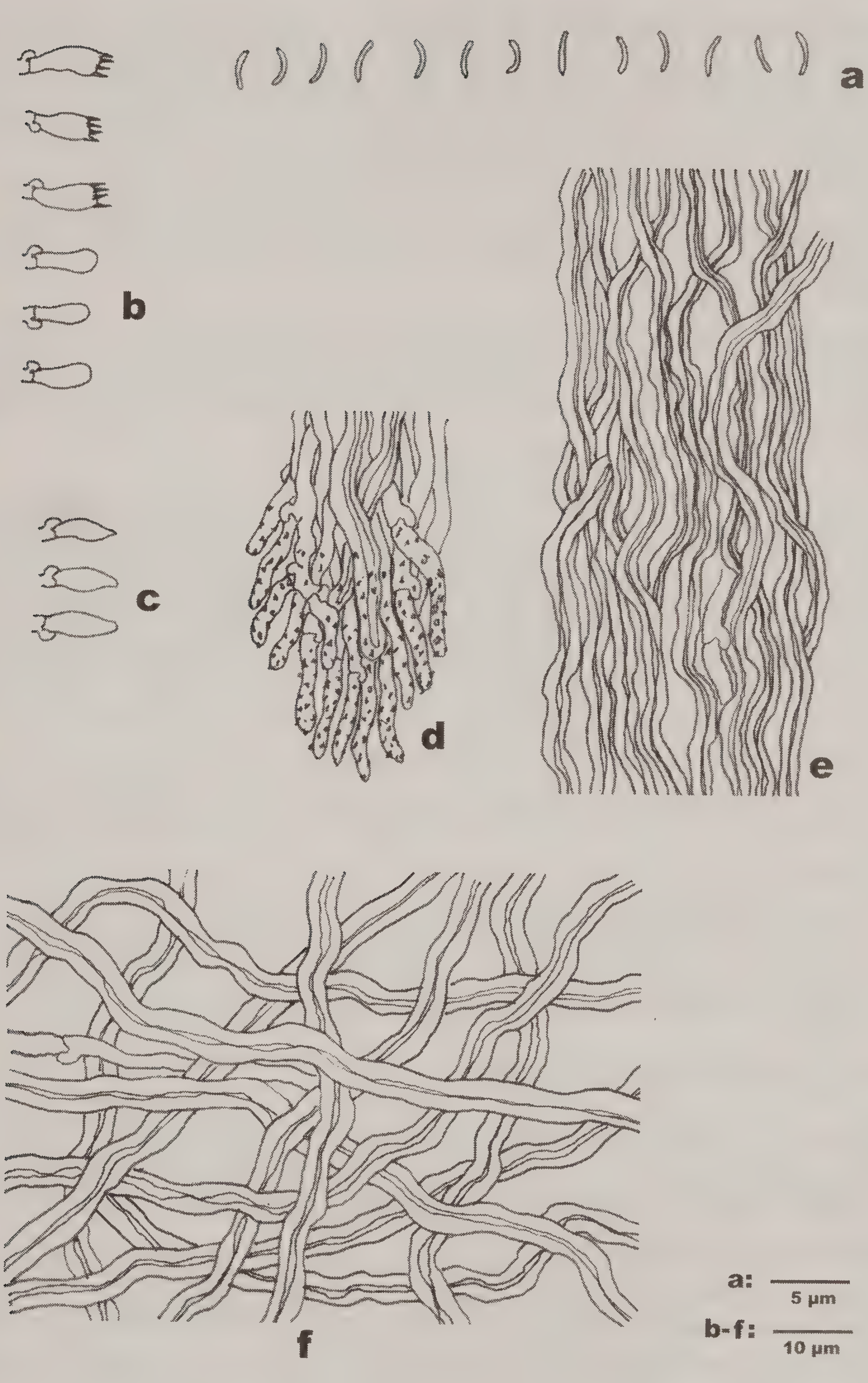

FIG. 1. Microscopic structures of *Skeletocutis luteolus* (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Cystidioles. —d: Hyphae from dissepiment edge. —e: Hyphae from trama. —f: Hyphae from subiculum.

surface white to cream when fresh, buff-yellow when bruised or upon drying, sometimes becoming buff to orange buff with age; margin cream buff, narrow to almost lacking. Pores round to angular, 5–7 per mm; dissepiments thin, entire to slightly lacerate. Subiculum cream, corky upon drying, less than 0.5 mm thick. Tubes cream to buff, corky, up to 0.3 cm long.

HYPHAL STRUCTURE — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae thick-walled, dominant, IKI–, CB–; all hyphae unchanged in KOH.

SUBICULUM — Generative hyphae hyaline, thin-walled, frequently branched, some covered by fine, sharp-pointed encrustations, 1.7–3 μm in diam.; skeletal hyphae dominant, thick-walled to subsolid, occasionally branched, tightly interwoven, 2.6–5 μm in diam.

TUBES — Generative hyphae hyaline, thin-walled, often branched, some encrusted by fine crystals, 1.5–2.8 μm in diam.; skeletal hyphae thick-walled to subsolid, rarely branched, agglutinated, subparallel along the tubes, 2–4.8 μm in diam. Dissepiment edge with both generative and skeletal hyphae; generative hyphae mostly covered by fine, sharp-pointed encrustations. Cystidia absent; fusoid cystidioles abundant, hyaline, thin-walled, 8–10 × 3–3.7 μm. Basidia short clavate, with four sterigmata and a basal clamp connection, 6–9 × 3–4 μm; basidioles in shape similar to basidia, but slightly smaller.

SPORES — Basidiospores allantoid, hyaline, thin-walled, smooth, IKI–, CB–, (2.9–)3–3.6(–3.8) × 0.4–0.7 μm, L = 3.18 μm, W = 0.54 μm, Q = 5.83–6.05 (n = 43/2).

ADDITIONAL SPECIMENS (PARATYPES) EXAMINED. — **China.** Fujian Prov., Jian'ou County, Wanmulin Nature Reserve, on rotten angiosperm wood, 30.VIII.2006 *Cui 4229* (BJFC). Hainan Prov., Wuzhishan County, Wuzhishan Nature Reserve, on fallen angiosperm trunk, 24.XI.2007 *Yang 781* (IFP); on fallen angiosperm trunk, 25.XI.2007 *Yang 795* (IFP).

TYPE OF ROT — White rot.

REMARKS — *Skeletocutis luteolus* belongs to the member of the *Skeletocutis subincarnata* complex because it has resupinate basidiocarps, dimitic hyphal structure with encrusted dissepiment edge, fusoid cystidioles, narrow and allantoid basidiospores.

Six species with narrow basidiospores (less than 1 μm in width) in the *Skeletocutis subincarnata* complex were reported by Niemelä (1998): *S. chrysella* Niemelä, *S. hymeniicola* (Murrill) Niemelä, *S. kuehneri* A. David, *S. ochroalba* Niemelä, *S. stellae* (Pilát) Jean Keller, *S. nivea* (Jungh.) Jean Keller. However, the basidiospores in the first five species are wider (more than 0.7 μm in width), and they all occur in boreal or temperate forest (Niemelä 1998). *Skeletocutis nivea* has similar very narrow (less than 0.7 μm in width) and allantoid basidiospores as in *S. luteolus*, and it has a distribution from boreal to tropics. However, *Skeletocutis nivea* has effused-reflexed basidiocarps and smaller pores (8–10 per mm, Gilbertson & Ryvarden 1987, Núñez & Ryvarden 2001, Ryvarden & Gilbertson 1993), and its pore surface usually becomes bluish-grey or dirty grey when bruised or dry (Núñez & Ryvarden 2001). In addition, *Skeletocutis nivea* has a monomitic tramal hyphae. In contrast, *Skeletocutis luteolus* is a fully resupinate species; its pores are buff-yellow when drying, and pores are slightly larger (5–7 per mm). Microscopically its tramal hypahe are distinctly dimitic.

Soon a new species with very thin basidiospores will be described in the genus from warm temperate China: *Skeletocutis fimbriata* Juan Li & Y.C. Dai. But this species has distinct rhizomorph and larger pores (4–5 per mm, Li et al. 2008).

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Literature cited

Anonymous. 1969. Flora of British fungi. Colour identification chart. Her Majesty´s Stationery Office, London.

Dai YC. 1998. Changbai wood-rotting fungi 9. Three new species and other species in *Rigidoporus*, *Skeletocutis* and *Wolfiporia* (*Basidiomycota, Aphyllophorales*). Ann. Bot. Fennici 35:143–154.

Dai YC, Cui BK. 2006. Two new species of *Wrightoporia* (*Basidiomycota, Aphyllophorales*) from southern China. Mycotaxon 96: 199–206.

Gilbertson RL, Ryvarden L. 1987. North American polypores 2. *Megasporoporia - Wrightoporia*. Fungiflora, Oslo. 434–885 pp.

Li J, Dai YC, Xiong HX. 2008. Two new polypores (*Basidiomycetes*) from central China. Ann. Bot. Fennici (in press).

Niemelä T. 1998. The *Skeletocutis subincarnata* complex (Basidiomycetes), a revision. Acta Bot. Fennica 161: 1–35.

Núñez M, Ryvarden L. 2001. East Asian polypores 2. *Polyporaceae* s. lato. Syn. Fungorum 14: 165–522.

Petersen JH. 1996. Farvekort. The Danish Mycological Society´s colour-chart. Foreningen til Svampekundskabens Fremme, Greve.

Ryvarden L, Gilbertson RL. 1993. European polypores 2. Syn. Fungorum 7: 388–743.

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A new species of *Phellinus* (*Basidiomycota, Hymenochaetales*) from western China

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Abstract — *Phellinus pseudoigniarius* sp. nov., collected on *Salix* from Xinjiang in western China, is described and illustrated. It belongs to the *Phellinus igniarius* complex and has a perennial and ungulate basidiocarp. Microscopically it differs from other species in the complex by lack of setae and presence of cystidioles.

Key words — *Hymenochaetaceae*, lignicolous and poroid fungi, taxonomy

Introduction

During a field trip to southern Xinjiang Autonomous Region in western China, two remarkable specimens of *Phellinus* Quél. were collected on trees of *Salix*. Macroscopically these samples are very similar to *Phellinus igniarius* (L.: Fr.) Quél., but distinct by lack of hymenial setae. With additional characters observed in the laboratory, they turn out to represent an undescribed species that we describe as new in this paper.

Materials and methods

The studied specimens are deposited at the Herbarium of Beijing Forestry University (BJFC) and the Herbarium of Institute of Applied Ecology, Chinese Academy of Sciences (IFP). The microscopic procedure follows Dai (1999). In presenting the variation in the size of the spores, 5% of measurements were excluded from each end of the range, and are given in parentheses. In the text the following abbreviations are used: IKI = Melzer's reagent, IKI– = negative in Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB+ =

cyanophilous, CB– = acyanophilous, L = mean spore length (arithmetic average of all spores), W = mean spore width (arithmetic average of all spores), Q = variation in the L/W ratios between the specimens studied, n = number of spores measured from given number of specimens. Sections were studied at magnification up to ×1000 by using a Nikon Eclipse E600 microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Special colour terms followed Petersen (1996) and Anonymous (1969).

Description

Phellinus pseudoigniarius Y.C. Dai & Fan Yang, **sp. nov.** **Fig.1**

MycoBank MB 511501

Carpophorum perenne, pileatum. Facies pororum submurina, pori rotundi, 3–5 per mm. Systema hypharum dimiticum, hyphae generatoriae septatae, hyphae skeletales contextum 4–6 μm in diam. Sporae late ellipsoideae, hyalinae, crassitunicatae, IKI–, CB(+), 5–5.9 × 4–4.8 μm.

TYPE. — **China.** Xinjiang Auto. Reg., Aksu, Wensu Country, Tumer Peak Nature Reserve, alt. 2650, on living tree of *Salix*, 24.VIII.2007 *Yang 67* (HOLOTYPE in IFP, isotype in BJFC and H).

ETYMOLOGY — *Pseudoigniarius* (Lat.): resembling *Phellinus igniarius.*

FRUITBODY — Basidiocarps perennial, pileate, ungulate, in section triquetrous, usually solitary, firmly attached to substrate, and woody hard, pileus projecting up to 22 cm, 27 cm broad, and 14 cm thick at base. Pileal surface ash grey to dark grey, concentrically sulcate with wide zones, glabrous with age, usually distinctly crustose, cracked to slightly rimose with age, margin obtuse, greyish brown, matted. Pore surface mouse grey to greyish brown, margin narrow to almost lacking; pores circular, 3–5 per mm (n=40/2), mostly 4 per mm, dissepiments thick, entire. Context clay brown, darker contrasting with tubes, woody hard, distinctly zonate, up to 2 cm thick, white mycelial strands occasionally present, granular core absent, an ash grey crust covering the context. Tubes clay brown, woody hard, up to 12 cm long, strongly filled with white mycelial strands in old tubes, tube layers usually distinct.

HYPHAL STRUCTURE — Hyphal system dimitic; all septa without clamp connections; Hyphae IKI–, CB–; tissue darkening but otherwise unchanged in KOH.

CONTEXT — Generative hyphae infrequent, hyaline to pale yellowish, thin-walled, occasionally branched, frequently simple septate, 3–4 μm in diam; skeletal hyphae dominant, rust brown, thick-walled with a wide lumen, unbranched, occasionally septate, mostly straight, some winding, interwoven, 4–6 μm in diam.

TUBES — Trama dominated by skeletal hyphae; generative hyphae infrequent, hyaline, thin- to slightly thick-walled, occasionally branched, frequently

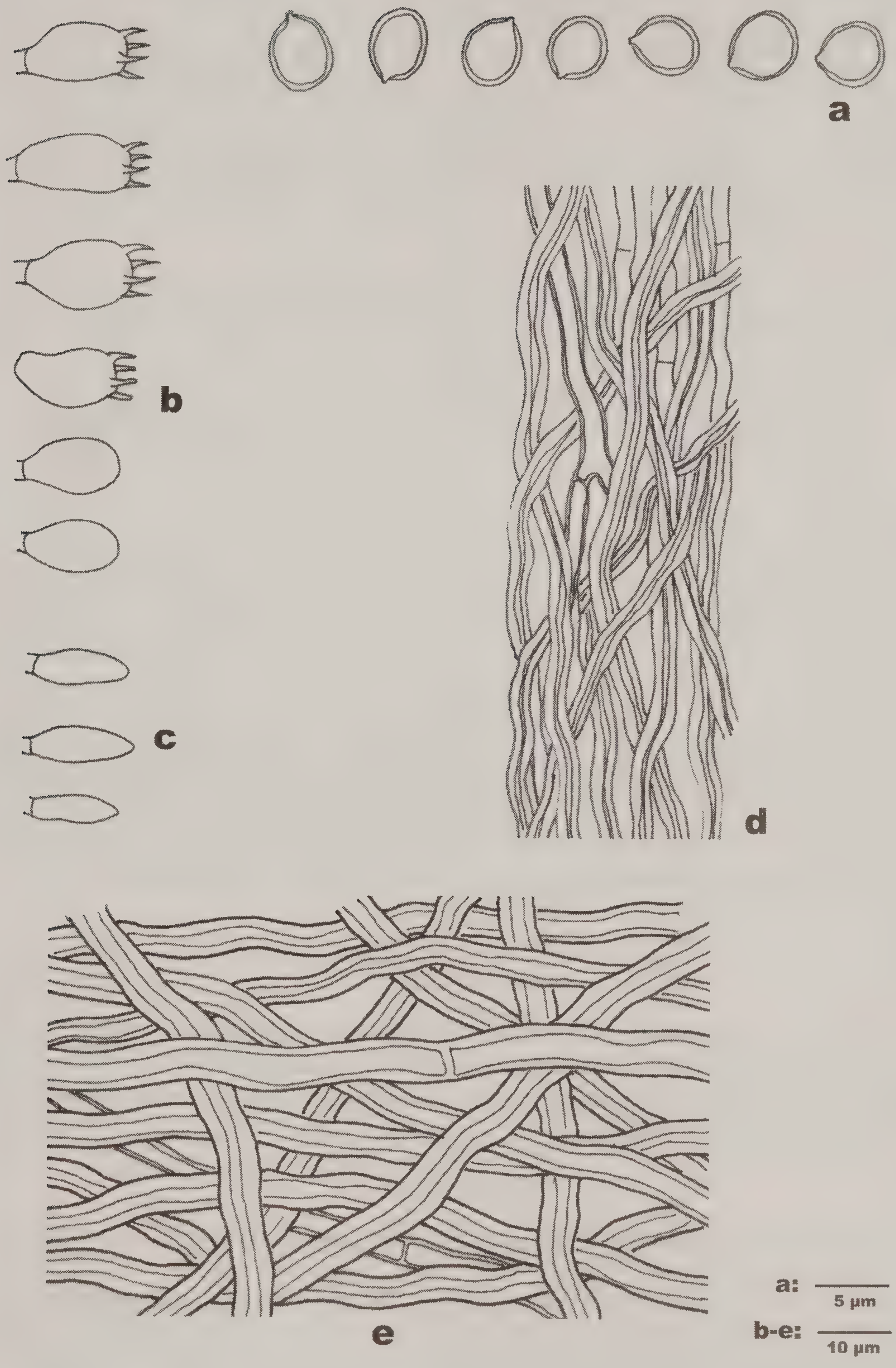

Fig. 1 Microscopic structures of *Phellinus pseudoigniarius* (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Cystidioles. —d: Hyphae from trama. —e: Hyphae from context.

simple septate, 2–3 µm in diam; skeletal hyphae rust brown, thick-walled with a medium to wide lumen, rarely branched, occasionally septate, winding to straight, loosely interwoven, 3–4.5 µm in diam. Setae absent; fusoid cystidioles occasionally present; basidia broadly clavate to barrel-shaped, with four sterigmata and a simple septum at the base, 11–15 × 6.5–8.5 µm; basidioles dominant in hymenium, in shape similar to basidia, slightly shorter than basidia; secondary hyphae hyaline, thin-walled, strongly branched, frequently septate, mostly collapsed, 1.2–2 µm in diam.

SPORES — Basidiospores broadly ellipsoid, hyaline, thick-walled, sometimes bearing a guttule, smooth, IKI–, moderately CB+, (4.8–)5–5.9(–6) × (3.9–)4–4.8 (–5.1) µm, L=5.31 µm, W=4.34 µm, Q=1.21–1.24 (n=60/2).

ADDITIONAL SPECIMEN (PARATYPE) EXAMINED. — **China.** Xinjiang Auto. Reg., Aksu, Wensu Country, Tumer Peak Nature Reserve, alt. 2650, on rotten wood of *Salix*, 24.VIII.2007 *Yang 71*(IFP).

TYPE OF ROT — White rot.

REMARKS — *Phellinus pseudoigniarius* belongs to the *P. igniarius* complex, and macroscopically it is very similar to *P. igniarius*. However, other species in the *P. igniarius* complex have hymenial setae, while *P. pseudoigniarius* is a setaeless species. In addition, basidiospores of the new species are slightly smaller than those in *P. igniarius* (5–5.9 × 4–4.8 µm vs. 5.2–6.8 × 4.5–5.9 µm, Niemelä 2005). *Phellinus pseudoigniarius* and *P. populicola* Niemelä have very similar basidiospores, but the latter has hymenial setae, lacks cystidioles, strongly interwoven tramal hyphae, and it has only been reported on *Populus tremula* (Niemelä, 1975). In contrast, *Phellinus pseudoigniarius* lacks hymenial setae, and has fusoid cystidioles; its tramal hyphae are loosely interwoven, and it was collected on *Salix* in very dry environment.

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Literature cited

Anonymous. 1969. Flora of British fungi. Colour identification chart. Her Majesty's Stationery Office, London.

Dai YC. 1999. *Phellinus sensu lato* (*Aphyllophorales, Hymenochaetaceae*) in East Asia. Acta Bot. Fennica 166: 1–115.

Niemelä T. 1975. On Fennoscandian Polypores 4. *Phellinus igniarius*, *P. nigricans* and *P. populicola, n. sp.* — Ann. Bot. Fennici 12: 93–122.

Niemelä T. 2005 Polypores, lignicolous fungi. Norrlinia 13: 1–320.

Petersen JH. 1996. Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve.

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Graphis fujianensis, a new species of *Graphidaceae* from China

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Abstract—*Graphis fujianensis*, from Wuyi Mountain in Fujian, China, is described as new to science.

Key words— curved ascospores, stictic acid

Introduction

During a study of the lichen family *Graphidaceae* (*Ostropales*, *Ascomycota*) in China, an interesting saxicolous species new to science was found. It is placed in the genus *Graphis* as delimited by Staiger (2002).

Material and methods

The type specimen was collected in the forest Wanmulin in Wuyishan, Fujian province, Southern China.

A dissecting microscope (TECH XTS-20) and a research microscope (OLYMPUS CHB-213) were used for the morphological and anatomical studies. Manual cross-sections of lirellae were examined in tap water. The lichen compound was detected by thin-layer chromatography (TLC) (Culberson & Kristensson, 1970; Culberson, 1972).

Taxonomic description

Graphis fujianensis Z.F Jia & J.C. Wei, **sp. nov.** FIGURE 1

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Differt a G. saxicola ascosporis minoribus curvatibus, sine marginibus thallinis apotheciorum et acidum sticticum cotinenti.

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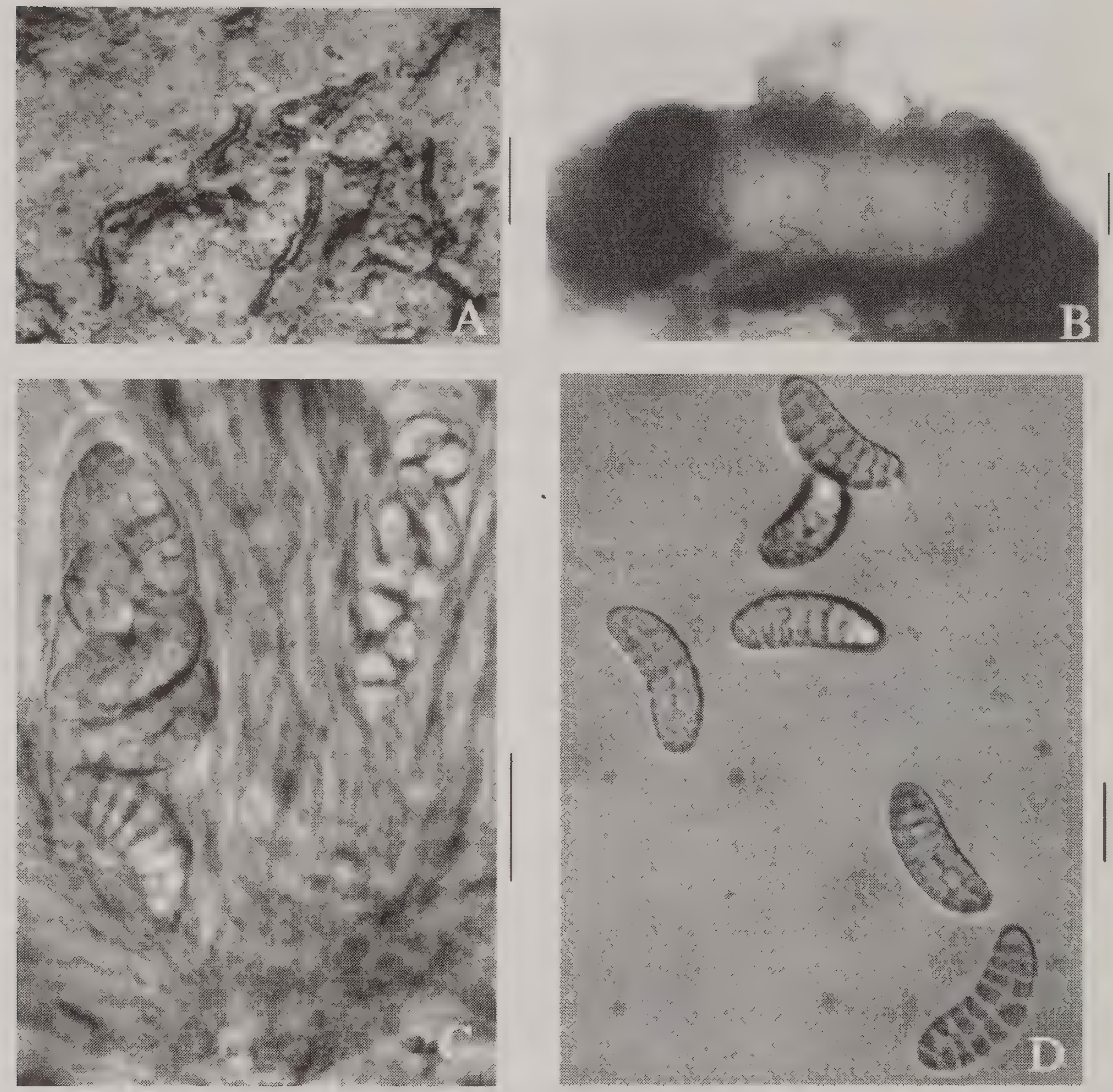

Fig. 1 *Graphis fujianensis*. A. Habit (bar = 1 mm); B. Apothecium cross section (bar = 50 μm); C. Two asci containing ascospores (bar = 20 μm); D. Curved, muriform ascospores (bar = 20 μm)

Typus: CHINA. Fujian Provincia, Jian-ou, Wanmulin, alt. 580m, ad saxa. 2/VI/2007, *Li Jing FJ1182*, (holotypus in LHS; isotypus in HMAS-L.).

Etymology: The specific epithet "fujianensis" is derived from the type locality in Fujian province.

Thallus crustose, pale grayish-white, thin, saxicolous, with dull surface. Apothecia lirelliform, black, conspicuous, initially fissurine, becoming sub-immersed to sessile, with slightly raised margins, curved and sinuous, lips sometimes opening slightly, 0.5-4 mm long, 0.1-0.25 mm wide, not grooved, without thalline margins; proper exciple completely carbonized; hymenium hyaline, not inspersed, 100-120 μm tall, clear, I-ve, epithecium 20-28.5 μm tall, brownish; paraphyses up to 1.5 μm wide, septate, slightly widened at apices;

ASCI cylindric, 70-80 × 13-20 μm, 8-spored; ASCOSPORES oblong-ellipsoid to slightly curved, hyaline, 17.5-33 μm long, 9-13 μm wide, muriform, 8-10 × 1-3-locular, I+ blue.

CHEMISTRY: C-, K+ yellow, P+red; stictic acid (TLC).

The new species differs from *Graphis saxicola* (Müll. Arg.) A.W. Archer (1999, 2005) by the smaller and curved ascospores, the lack of thalline margins and the presence of stictic acid.

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Literature cited

Archer AW. 1999. The lichen genera *Graphis* and *Graphina* (*Graphidaceae*) in Australia. 1. Species based on Australian Type specimens. Telopea 8(2): 273-295.

Archer AW. 2005. New combinations and synonymies in the Australian *Graphidaceae.* Telopea 11(1): 59-78.

Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. Journal of Chromatography 72: 113-125.

Culberson CF, Kristensson H. 1970. A standardized method for the identification of lichen products. Journal of Chromatography 46: 85-93.

Staiger B. 2002. Die Flechtenfamilie *Graphidaceae* Studien in Richtung einer natürlicheren Gliederung. Bibliotheca Lichenologica 85: 1-526.

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Pilobolus (*Mucoraceae*) from herbivore dung in Recife, Pernambuco, Brazil

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Abstract — Four species of *Pilobolus*, including seven varieties, were studied from tapir (*Tapirus terrestris*), camel (*Camelus bactrianus*), agouti (*Dasyprocta aguti*), donkey (*Equus asinus*), llama (*Lama glama*), horse (*Equus caballus*), deer (*Cervus elaphus*) and waterbuck (*Kobus ellipsiprymnus*) dung collected at the Reserva Ecológica de Dois Irmãos (8°7'30" S and 34°52'30" W), located in Recife, State of Pernambuco, Northeast Brazil. *Pilobolus crystallinus* var. *hyalosporus*, *Pilobolus roridus* var. *roridus* and *P. roridus* var. *umbonatus* are reported for the first time in Brazil. An identification key for species of *Pilobolus* studied in Brazil is provided.

Key words — *Mucoromycotina*, coprophilous, taxonomy

Introduction

Pilobolus belongs to the subphylum *Mucoromycotina* (Hibbett et al. 2007), family *Mucoraceae*, order *Mucorales* (Benny 2005) and has been described as comprising obligate coprophilous fungi (Krug et al. 2004). Grove (1934) provided an important taxonomic study that included a delimitation of the species of *Pilobolus*, descriptions and illustrations of nine recognized species out of which seven were considered doubtful. Since then, valuable contributions have been given by Naumov (1939), McVickar (1942), Boedijn (1958), Nand & Mehrotra (1968, 1977), Tandon (1968), Zycha et al. (1969), Zheng & Hu (1979), Foos & Rakestraw (1985), Foos (1989), Foos & Royer (1989), among others. However, the latest study of this genus was given by Hu et al. (1989), who recognized five species comprising seven varieties: *P. crystallinus* var. *crystallinus*, *P. crystallinus* var. *hyalosporus*, *P. crystallinus* var. *kleinii*, *P. lentiger* var. *lentiger*, *P. lentiger* var. *minutus*, *P. longipes*, *P. oedipus*, *P. roridus* var. *roridus* and *P. roridus* var. *umbonatus*.

Considering that there are few reports relating to *Pilobolus* species in Brazil (Batista 1948, Batista & Pontual 1948, Trufem 1984, Viriato & Trufem 1985) and that some described species are doubtful and/or synonyms of other recognized species, the purpose of this paper is to describe and illustrate species of *Pilobolus* from the dung of mammalian herbivores kept in captivity in Recife, PE, and to provide an identification key for *Pilobolus* studied in Brazil.

Material and methods

Samples of dung of tapir (*Tapirus terrestris*), camel (*Camelus bactrianus*), agouti (*Dasyprocta aguti*), donkey (*Equus asinus*), llama (*Lama glama*), horse (*Equus caballus*), deer (*Cervus elaphus*) and waterbuck (*Kobus ellipsiprymnus*) were collected at the Reserva Ecológica de Dois Irmãos (8°7'30"S and 34°52'30"W), which includes a Zoological Park, located in Recife, State of Pernambuco, Northeast of Brazil. The area contains 387 ha, and is an Atlantic Forest Ecological Reserve.

The samples were collected monthly, from June 2005 to May 2006, resulting in a total of 96 samples. They were collected with a sterilized spatula, placed in plastic bags, taken to the laboratory and incubated in moist chamber at 28°C ± 2°C for 7 days under light and dark periods. The specimens were studied directly from the substrata under stereomicroscope and light microscope. In addition to the species here studied, our identification key includes *Pilobolus oedipus* which was studied by Viriato & Trufem (1985) from horse dung in São Paulo, SP, Brazil.

Taxonomy

Pilobolus crystallinus (F.H. Wigg.) Tode var. ***crystallinus***,
Schrift. Berl. Gesell. naturf. Freunde 5: 47 (1784) **Fig. 1 a-d**

SPORANGIOPHORES erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic, 1.3–10 mm × 43–160 µm. TROPHOCYSTS subglobose to ellipsoid, buried in the substratum, terminal, sometimes intercalary, 170–740 × 180–370 µm. SUBSPORANGIAL SWELLINGS ovoid and ovoid-ellipsoid, orange at the base, 130–200 × 155–235 µm. SPORANGIA hemispherical, black, 55–335 × 135–440 µm. COLUMELLAE nipple-like, 155–200 × 155–290 µm. SPORANGIOSPORES ellipsoid, smooth-walled, pale yellow or hyaline, 7.5–11 × 5–7.5 µm. ZYGOSPORES not found.

HABITAT: Tapir, camel, donkey, elk and waterbuck dung. In Brazil, *P. crystallinus* var. *crystallinus* was previously found on goat (Batista 1948), camel, horse, giraffe, guanaco, wildebeest, (Viriato & Trufem 1985), bighorn sheep, gemsbok and brocket deer (Trufem 1984) dung. This species was also observed on buffalo (Nand & Mehrotra 1968, 1977), elephant (Hu et al. 1989, Masunga et al. 2006), kangaroo (Nagy & Harrower 1979, Hu et al. 1989), fox, mule, pig, muntjac (Hu et al. 1989), rabbit (Nagy & Harrower 1979, Hu et al. 1989, Richardson 2001), camel (Nand & Mehrotra 1968, 1977; Hu et al. 1989), deer, sheep (Hu et al. 1989, Richardson 2001), horse, cow (Foos & Rakestraw 1985, Hu et al. 1989, Richardson 2001), antelope, bighorn sheep, bison, mule deer (Foos & Royer 1989), hare (Richardson 2001), reedbuck, steenbuck, impala, waterbuck, hippopotamus, African buffalo, zebu, eland (Caretta et al. 1998), opossum (Bell 1975) and moose (Nyberg & Persson 2002) dung .

NOTES: The characteristics of the strains of *P. crystallinus* var. *crystallinus* reported here show a close similarity with the descriptions by Grove (1934), Boedijn (1958), Nand & Mehrotra (1968, 1977) and Hu et al. (1989). However, different size of sporangiophores has been reported. Grove (1934) and Hu et al. (1989) observed sporangiophores to be 5–12 mm long, differing from 10–38 mm (Nand & Mehrotra 1968, 1977) and 0.4–0.8 mm (Viriato & Trufem 1985). Trufem (1984) described this structure up to 15 mm.

Pilobolus crystallinus var. *crystallinus* differs from *P. crystallinus* var. *kleinii* mainly in possessing smaller, pale yellow or hyaline sporangiospores (7.5–11 × 5–7.5 µm). Sporangiospores of *P. crystallinus* var. *kleinii* are intense yellow and larger (10–19.5 × 5.5–8.5 µm).

P. crystallinus var. kleinii (Tiegh.) R.Y. Zheng & G.Q. Chen,
Mycosystema 2: 119 (1989) **Fig. 1 e-h**

SPORANGIOPHORES erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic, 2.2–6.7 mm × 95–155 µm. TROPHOCYSTS buried in the substratum, ovoid-cylindrical, 310–860 × 190–420 µm. SUBSPORANGIAL SWELLINGS ovoid and slightly ellipsoid, orange brown at base, 410–600 × 330–510 µm. SPORANGIA hemispherical, black, 125–340 × 170–460 µm. COLUMELLAE conical-cylindrical, some slightly narrowed at the middle, 190–230 × 250–345 µm. SPORANGIOSPORES ellipsoid, intense yellow or orange-yellow, 10–19.5 × 5.5–8.5 µm. ZYGOSPORES not found.

HABITAT: Camel, horse, llama, donkey, deer and tapir. In Brazil, there are reports from cow (Batista 1948), horse, giraffe, guanaco, gnu (Viriato & Trufem 1985), camel and gemsbok (Trufem 1984, Viriato & Trufem 1985) dung. The occurrence of *P. crystallinus* var. *kleinii* from the dung of buffalo (Nand & Mehrotra 1968, 1977), sheep, deer, rabbit (Caretta & Piontelli 1996, Hu et al. 1998, Richardson 2001), elephant, fox, kangaroo, mule, pig, muntjac (Hu et al. 1998), horse (Piontelli et al. 1981, Foos & Royer 1989, Hu et al. 1998) cow, camel (Nand & Mehrotra 1968, 1977; Abdullah 1982, Hu et al. 1998, Richardson 2001), antelope, bighorn sheep, moose (Foos & Royer 1989) and donkey (Abdullah 1982) was previously cited.

Notes: The characteristics of the strains of *Pilobolus crystallinus* var. *kleinii* reported here show a close similarity with the descriptions of Grove (1934), Naumov (1939), Boedijn (1958), Nand & Mehrotra (1968, 1977) and Hu et al. (1989). However, different sizes of trophocysts were reported by several authors. We observed trophocysts with 310–860 × 190–420 µm, but Hu et al. (1989) and Boedijn (1958) reported trophocysts with 140–455 × 125–295 µm and 400–460 × 200–250 µm, respectively.

Different from what most authors have cited, we found some specimens with sporangiophores up to 1.5 cm in length, trophocysts subglobose to ellipsoid, collumelae conical and sporangiospores broader, strong orange, 10–17.5 × 7.5–12.5. These specimens produce bigger and broader sporangiospores than those of *P. crystallinus* var. *crystallinus*, broader sporangiospores than those referred to *P. crystallinus* var. *kleinii*, and bigger, more intensely colored sporangiospores than those referred to *P. crystallinus* var. *hyalosporus*. However, Boedijn (1958), who reported an isolate from pig dung with broader (9–12 × 6–8 µm), dark yellow sporangiospores, did not consider these differences enough to characterize a new variety.

Pilobolus crystallinus* var. *hyalosporus (Boedijn) F.M. Hu & R.Y. Zheng,
Mycosystema 2: 119 (1989) **Fig. 1 i-l**

Sporangiophores erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic, 1–3 mm × 85–125 µm. Trophocysts buried in the substratum, ovoid, some elliptical, 335–500 × 200–400 µm. Subsporangial swellings ovoid, light orange at base, 230–730 × 210–490 µm. Sporangia hemispherical, black, 135–170 × 180–345 µm. Columellae nipple-like 100–190 × 90–140 µm. Sporangiospores ovoid, pale yellow, almost hyaline, 7.5–10 × 5.5–8 µm. Zygospores not found.

Habitat: Tapir, camel, donkey and llama dung. Hu et al. (1989) report this variety for camel, chicken, cow, deer, mule, horse, monkey, rat, pig and sheep dung (Hu et al. 1989). This is the first record of *P. crystallinus* var. *hyalosporus* for Brazil.

Notes: *Pilobolus crystallinus* var. *hyalosporus* differs from *P. crystallinus* var. *crystallinus* and from *P. crystallinus* var. *kleinii* in producing broader, paler sporangiospores (Hu et al. 1989). Sporangiospores of *P. crystallinus* var. *hyalosporus* are also shorter than those of *P. crystallinus* var. *kleinii*.

Pilobolus lentiger Corda **var. *lentiger***, Icon. Fung. (Prague) 1: 22 (1837) Fig 1. m-p

= *Pilobolus borzianus* Morini

= *Pilobolus sphaerosporus* (Grove) Palla

Sporangiophores erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic, 1.8–6 mm × 65–125 µm. Trophocysts buried in the substratum, ovoid, some elliptical, 290–395 × 240–330 µm. Subsporangial swellings elliptical, smooth-walled, orange at base, some filled with light orange brown pigment, 310–470 × 170–350 µm. Sporangia hemispherical, black, 135–270 × 200–320 µm. Columellae obtusely conical, smooth-walled, 160–190 × 240–330 µm. Sporangiospores globose, yellow, some orange, granular content, 7.5–17 µm diam. Zygospores not found.

Habitat: Tapir, camel, donkey and deer dung. In Brazil, there are occurrence reports of *P. lentiger* var. *lentiger* (as *P. borzianus* and *P. sphaerosporus*) from horse (Viriato & Trufem 1985, Richardson 2001), camel, giraffe, gnu, gemsbok, scimitar oryx, zebra (Viriato & Trufem 1985), sheep and capybara (Richardson 2001) dung. According to Hu et al. (1989), *P. lentiger* var. *lentiger* can also be found in bear, camel, cat, chicken, cow, deer, elephant, fox, horse, leopard, monkey, rat, mule, panda, pig and sheep dung. This is the first report of *P. lentiger* var. *lentiger* for Brazil.

Notes: *Pilobolus lentiger* var. *lentiger* presents several synonyms and have been mainly described as *P. borzianus* (Grove 1934, Boedijn 1958, Naumov 1939, Nand & Mehrotra 1968, 1977; Tandon 1968, Viriato & Trufem 1985) and *P. sphaerosporus* (Grove 1934, Naumov 1939, Nand & Mehrotra 1968, 1977; Zycha et al. 1969, Viriato & Trufem 1985). Hu et al. (1989) considered *P. borzianus* and *P. sphaerosporus* as synonyms of *Pilobolus lentiger* var. *lentiger*

Pilobolus lentiger var. *lentiger* is similar to *P. lentiger* var. *minutus* but differs primarily in its larger sporangiospore size. Different sporangiospores sizes are described for *P. borzianus* — 16–23 µm diam (Grove 1934); 8–15 µm diam (Nand & Mehrotra 1977); 9–22 µm diam (Viriato & Trufem 1985) — and for *P. sphaerosporus* — (6–)12–20 µm diam (Zycha et al. 1969); 6.5–12.5 µm diam (Nand & Mehrotra 1977) and 8–14 µm diam (Viriato & Trufem 1985).

Pilobolus lentiger **var. *minutus*** (Speg.) R.Y. Zheng & G.Q. Chen, Mycosystema 2: 122 (1989) **Fig 2. a-d**

≡ *Pilobolus minutus* Speg.,

= *Pilobolus morinii* Sacc.

Sporangiophores erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic, 1.3–7 mm × 85–150 µm. Trophocysts buried in the substratum, subglobose to ovoid, 180–610 × 125–270 µm. Subsporangial

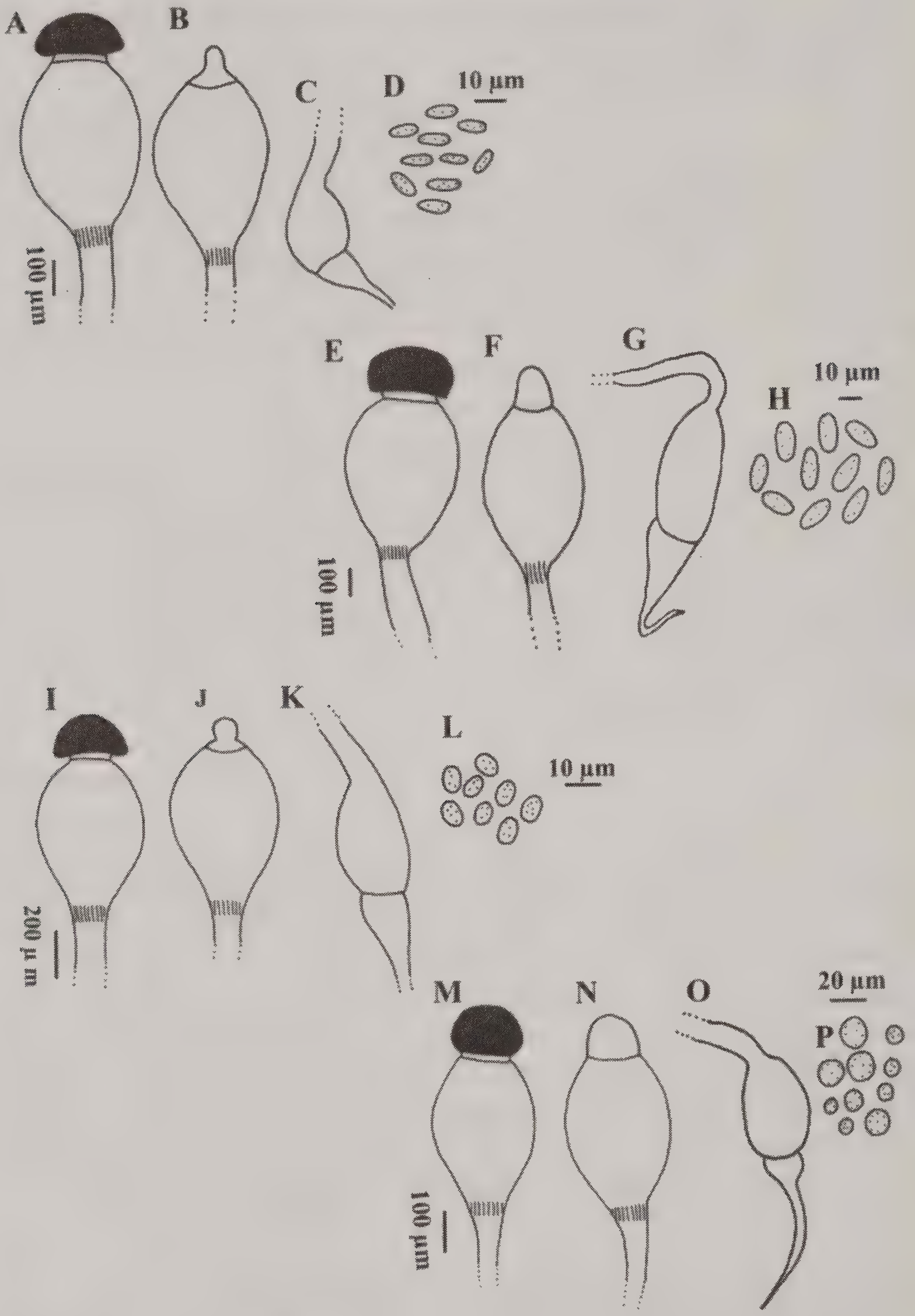

Fig 1 *Pilobolus crystallinus* var. *crystallinus* A–D: A) Subsporangial swelling and sporangium; B) Subsporangial swelling and columella; C) Trophocyst; D) Sporangiospores. *P. crystallinus* var. *kleinii* E–H: E) Subsporangial swelling and sporangium; F) Subsporangial swelling and columella; G) Trophocyst; H) Sporangiospores. *P. crystallinus* var. *hyalosporus* I–L: I) Subsporangial swelling and sporangium; J) Subsporangial swelling and columella; K) Trophocyst; L) Sporangiospores. *P. lentiger* var. *lentiger* M–P: M) Subsporangial swelling and sporangium; N) Subsporangial swelling and columella; O) Trophocyst; P) Sporangiospores.

SWELLINGS ovoid, orange at base, 290–490 × 200–375 µm. SPORANGIA subglobose to hemispherical, black, 135–240 × 180–330 µm. COLUMELLAE cylindrical, some slightly narrowed at the middle, smooth-walled, 140–230 × 130–300 µm. SPORANGIOSPORES yellow, globose, 7–11 µm diam. ZYGOSPORES not found.

HABITAT: Tapir, camel, agouti, donkey, llama and deer dung. In Brazil, there are reports of *P. lentiger* var. *minutus* (as *P. morinii*) in camel, gnu, scimitar oryx and gemsbok (Viriato & Trufem 1985) dung. According to Hu et al. (1989), *P. lentiger* var. *minutus* can also be found in donkey, mule and sheep dung.

NOTES: *Pilobolus lentiger* var. *minutus* has often been cited as *P. morinii* and *P. minutus* (Grove 1934, Viriato & Trufem 1985, Boedijn 1958, Tandon 1968). Hu et al. (1989) treated *P. minutus* as a variety of *P. lentiger* and placed *P. morinii* in synonymy.

Pilobolus lentiger var. *minutus* is similar to *P. lentiger* var. *lentiger* but differs mainly in its smaller sporangiospore sizes. The different sporangiospore sizes cited for *P. morinii* are 5–9 µm diam (Viriato & Trufem 1985), 4.5–6 µm diam (Grove 1934), and 5.5–7 µm diam (Boedijn 1958).

Pilobolus longipes Tiegh.,

Annls Sci. Nat., Bot., sér. 6, 4(4): 338 (1878) ['1876'] **Fig. 2 e-h**

SPORANGIOPHORES erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic, 0.3–2.5 cm × 90–140 µm. TROPHOCYSTS very long, growing parallel to the substratum, yellow, 410–1800 × 240–420 µm. SUBSPORANGIAL SWELLINGS ovoid, smooth-walled, 385–1300 × 290–1370 µm orange at base. SPORANGIA globose, some hemispherical, black, 220–340 × 220–540 µm. COLUMELLAE conical, some rounded at apex, almost cylindrical, 75–330 ×170–375 µm. SPORANGIOSPORES globose and subglobose to ovoid, yellow, thick-walled, 10–18.5 µm in diam. ZYGOSPORES not found.

HABITAT: Camel, horse and donkey dung. In Brazil, *P. longipes* was registered on zebra (Viriato & Trufem 1985), gemsbok (Trufem 1984) and horse (Batista 1948, Trufem 1984, Viriato & Trufem 1985) dung. *P. longipes* can also be found in camel, cow, elephant, horse, mule and sheep dung (Hu et al. 1989).

NOTES: The characteristics of the strains of *P. longipes* reported here show a close similarity with the descriptions of Grove (1934), Naumov (1939), Nand & Mehrotra (1968, 1977), Tandon (1968), Trufem (1984), Viriato & Trufem (1985) and Hu et al. (1989).

Pilobolus longipes differs from other *Pilobolus* species primarily in producing a very long trophocyst that grows parallel to the substrata.

Pilobolus roridus (Bolton) Pers. **var. *roridus*,**
Syn. meth. fung. (Göttingen) 1: 118 (1801) **Fig. 2 i-l**

Sporangiophores erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic, 3–6 mm × 85–490 μm. Trophocysts ovate-ellipsoid, 230–385 × 125–290 μm. Subsporangial swellings ovoid, orange at base, 230–550 × 210–490 μm. Sporangia hemispherical, black, 96–150 × 130–310 μm. Columellae plane-convex, dark gray, 85–115 × 150–300 μm. Sporangiospores elliptical, light yellow, 4–7 × 3–4.5 μm. Zygospores not found.

Habitat: Horse and donkey dung. *Pilobolus roridus* var. *roridus* was reported from camel, chicken, cow, pig, sheep (Hu et al. 1998), goat, peacock (Nand & Mehrotra 1968, 1977), reedbuck, elk, moose, bighorn sheep and mule deer (Foos & Royer 1989) dung. This is the first report of *P. roridus* var. *roridus* for Brazil.

Notes: The strains of *P. roridus* var. *roridus* reported here share similar characteristics with those described by Grove (1934), Nand & Mehrotra (1968, 1977), Hu et al. (1989), Foos (1989) and Foos & Royer (1989). However, different sporangiophore sizes have been reported. Hu et al. (1989) and Foos (1989) observed sporangiophores with 4–12 mm and 2–3 mm in length, respectively. Foos & Royer (1989) reported 1–8 mm long sporangiophores, and Nand & Mehrotra (1977) and Grove (1934) cited lengths of 1–1.5 cm and 1–2 cm, respectively, for this structure.

Pilobolus roridus var. *roridus* is distinguished from other *Pilobolus* species by its dark grey, plano-convex columellae and reduced sporangia in relation to the subsporangial swelling.

Pilobolus roridus **var. *umbonatus*** (Buller) F.M. Hu & R.Y. Zheng, Mycosystema 2: 129 (1989) **Fig. 2 m-o**

Sporangiophores erect, long-cylindrical, unbranched, nonseptate, smooth-walled, phototrophic 3–9 mm × 85–145 μm. Trophocysts buried in the substratum, ovoid to napiform, 190–395 × 140–270 μm. Subsporangial swellings ovoid to ellipsoid, orange at base, 340–680 × 265–460 μm. Sporangia hemispherical, umbonate, black, 130–190 × 150–230 μm. Sporangiospores ellipsoid, light yellow to hyaline, 5–8 × 3.5–4 μm. Columellae not visualized. Zygospores not found.

Habitat: Horse dung. *Pilobolus roridus* var. *umbonatus* can also be found on cow, camel, pig and sheep (Hu et al. 1989) dung. This is the first report of *P. roridus* var. *umbonatus* for Brazil.

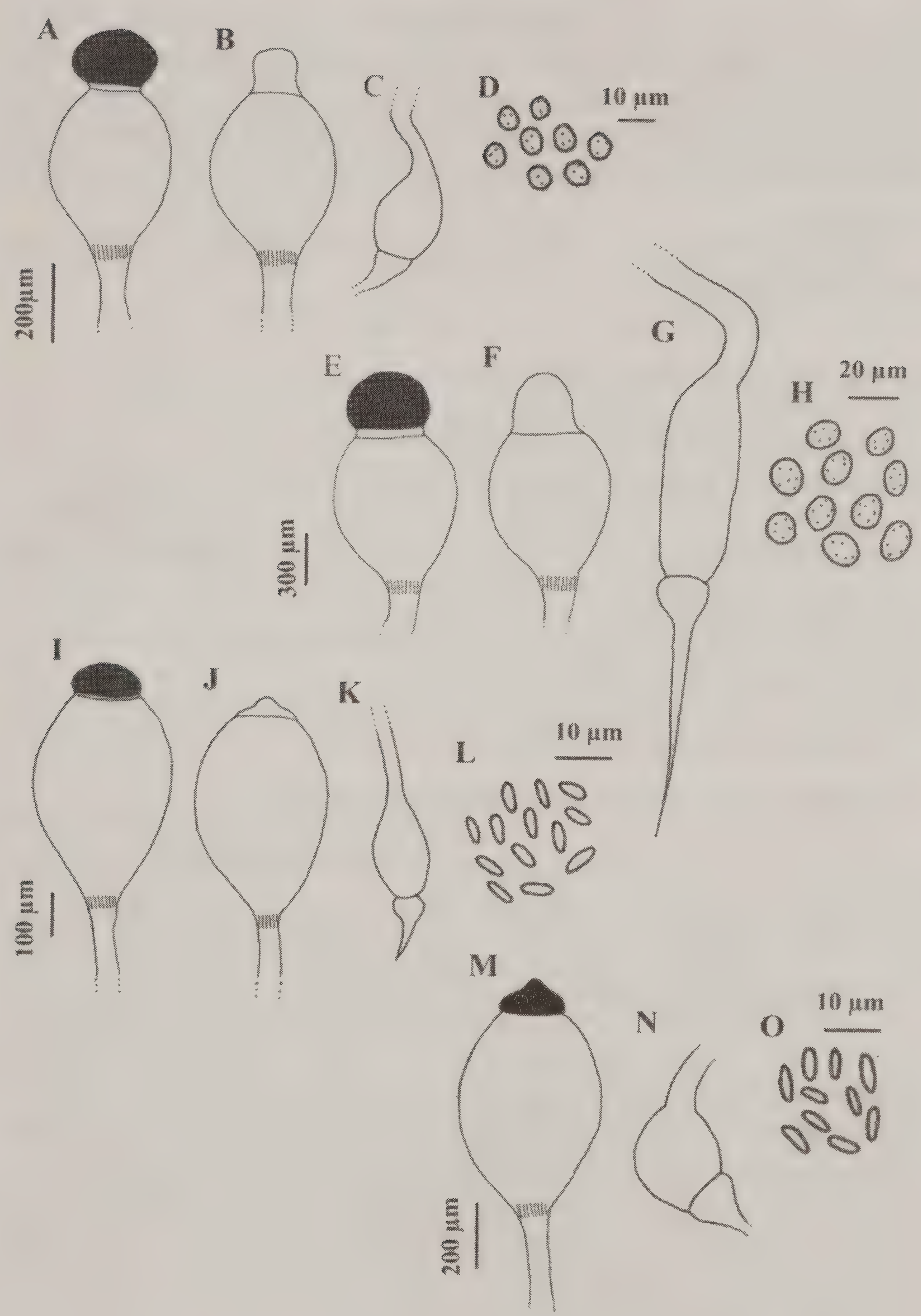

Fig. 2 *Pilobolus lentiger* var. *minutus* A–D: A) Subsporangial swelling and sporangium; B) Subsporangial swelling and columella; C) Trophocyst; D) Sporangiospores. *P. longipes* E–H: E) Subsporangial swelling and sporangium; F) Subsporangial swelling and columella; G) Trophocyst; H) Sporangiospores. *P. roridus* var. *roridus* I–L: I) Subsporangial swelling and sporangium; J) Subsporangial swelling and columella; K) Trophocyst; L) Sporangiospores. *P. roridus* var. *umbonatus* M–O: M) Subsporangial swelling and sporangium; N) Trophocyst; O) Sporangiospores.

Notes: The *P. roridus* var. *umbonatus* strain characteristics reported here are very similar to those cited by Grove (1934), Nand & Mehrotra (1968, 1977) and Hu et al. (1989). However, differences in the sizes of the subsporangial swellings were reported. Hu et al. (1989) described subsporangial swellings with 455–745 × 380–535 µm, while Nand & Mehrotra (1977) cited this structure with 90–500 × 80–400 µm.

Pilobolus roridus var. *umbonatus* differs from the other *Pilobolus* in possessing umbonate sporangia.

Identification key for species of *Pilobolus* from Brazil

1. Sporangiospores ellipsoid, if ovoid then up to 10 µm in length 2
1. Sporangiospores globose and subglobose to ovoid,
 the last ones up to 18.5 µm diam.. 6

2. Sporangia umbonate .... ***P. roridus*** **var.** ***umbonatus***
2. Sporangia not umbonate 3

3. Columellae nipple-like, conical to cylindrical, sporangiospores
 ellipsoid or ovoid with different sizes 4
3. Columellae plane-convex, dark gray, sporangiospores
 ellipsoid, 4–7 × 3–4.5 µm .... ***P. roridus*** **var.** ***roridus***

4. Sporangiophores 1–3 mm in length, sporangiospores ovoid
 7.5–10 × 5.5–8 µm .... ***P. crystallinus*** **var.** ***hyalosporus***
4. Sporangiophores up to 10 mm in length, sporangiospores ellipsoid............. 5

5. Columellae nipple-like, sporangiospores yellow or hyaline,
 7.5–11 × 5–7.5 µm .... ***P. crystallinus*** **var.** ***crystallinus***
5. Columellae conical-cylindrical, some slightly narrowed at the middle,
 sporangiospores intense yellow or orange-yellow, 10–19.5 × 5.5–8.5 µm
 .... ***P. crystallinus*** **var.** ***kleinii***

6. Trophocysts very long, growing parallel to the substratum,
 ≤1800 µm in length, sporangiophores ≤2.5 cm in length .... ***P. longipes***
6. Trophocysts buried in the substratum, ≤ 610 µm in length, ovoid to ellipsoid,
 subglobose to ovoid, napiform, sporangiophores up to 7 mm in length 7

7. Sporangiospores thick-walled, spherical to broad ovoid .... ***P. oedipus***
7. Sporangiospores thin-walled, globose 8

8. Columellae obtusely conical, 160–190 × 240–330 µm,
 sporangiospores globose, 7.5—17 µm diam.. .... ***P. lentiger*** **var.** ***lentiger***
8. Columellae cylindrical, some slightly narrowed at the middle,
 140–230 × 130–300 µm, sporangiospores globose
 7–11 µm diam. .... ***P. lentiger*** **var.** ***minutus***

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References

Abdullah SK. 1982. Coprophilous mycoflora on different dung types in southern desert of Iraq. Sydowia 35: 1–5.

Batista AC. 1948. *Pilobolus crystallinus* (Wiggs) Tode. Boletim da S. A. I. C. 15: 1–6.

Batista AC, Pontual D. 1948. Alguns fungos coprófilos de Pernambuco. Boletim da S. A. I. C. 15: 27–44.

Bell A. 1975. Fungal succession on dung of the brush-tailed opossum in New Zealand. New Zealand J. Bot. 13: 437–62.

Benny GL. 2005. *Zygomycetes*. Published on the Internet at http://www.zygomycetes.org.

Boedijn KB. 1958. Notes on the *Mucorales* of Indonesia. Sydowia 12: 321–362.

Caretta G, Piontelli E. 1996. Coprophilous fungi from confined deers in Pavia (Lombardia, Italy). Boletín Miológico 11 (1–2): 41–50.

Caretta G, Piontelli E, Savino E, Bulgheroni A. 1998. Some coprophilous fungi from Kenya. Mycopathologia 142: 125–134.

Foos MK, Rakestraw JB. 1985. A survey of *Pilobolus* from Lake County, Ohio. Ohio J. Sci. 85 (3): 137–138.

Foos, MK. 1989. Isolation of *Pilobolus* spp. from the northern elk herd in Yellowstone National Park. J. Wildlife Diseases 25 (2): 302–304.

Foos MK, Royer JA. 1989. A survey of *Pilobolus* from Yellowstone National Park. Mycotaxon 34 (2): 395–397.

Grove WB, 1934. A systematic account and arrangement of the *Pilobolidae*. 191–224, in AHR Buller (ed.), Researches on Fungi. Vol 6. London, Longmans Green and Co.

Hibbett DS, Binder M, Bischoff JF, Blackwell M, Cannon PF, Eriksson OE, Huhndorf S, James T, Kirk PM, Lücking R, Lumbsch HT, Lutzoni F, Matheny PB, McLaughlin DJ, Powell MJ, Redhead S, Schoch CL, Spatafora JW, Stalpers JA, Vilgalys R, Aime MC, Aptroot A, Bauer R, Begerow D, Benny GL, Castlebury LA, Crous PW, Dai YC, Gams W, Geiser DM, Griffith GW, Gueidan C, Hawksworth DL, Hestmark G, Hosaka K, Humber RA, Hyde KD, Ironside JE, Kõljalg U, Kurtzman CP, Larsson KH, Lichtwardt R, Longcore J, Miadlikowska J, Miller A, Moncalvo JM, Mozley-Standridge S, Oberwinkler F, Parmasto E, Reeb V, Rogers JD, Roux C, Ryvarden L, Sampaio JP, Schüßler A, Sugiyama J, Thorn RG, Tibell L, Untereiner WA, Walker C, Wang Z, Weir A, Weiss M, White MM, Winka K, Yao YJ, Zhang N. 2007. A higher-level phylogenetic classification of the fungi. Mycological Research 3: 509–547.

Hu FM, Zheng RY, Chen GQ. 1989. A redelimitation of the species of *Pilobolus*. Mycosystema 2: 111–133.

Krug JC, Benny GL, Keller HW. 2004. Coprophilous fungi. 467–499, in GM Mueller et al. (eds.), Biodiversity of fungi. Inventory and monitoring methods. London, Elsevier Academic Press.

Masunga GS, Andresen Ø, Taylor JE, Dhillion SS. 2006. Elephant dung decomposition and coprophilous fungi in two habitats of semi-arid Botswana. Mycological Research 110: 1214–1226.

McVickar DL. 1942. The light-controlled diurnal rhythm of asexual reproduction in *Pilobolus*. American Jour. Bot. 29: 272–3380.

Nand K, Mehrotra BS. 1968. Species of *Pilobolus* and *Pilaira* from India. Sydowia 22: 299–306.

Nand K, Mehrotra BS. 1977. Species of *Pilobolus* and *Pilaira* from India. Sydowia 30: 283–289.

Nagy LA, Harrower KM. 1979. Analysis of two southern hemisphere coprophilous fungus successions. Transactions of the British Mycological Society 72 (1): 69–74.

Naumov NA. 1935. Opredeliel Mukorovych (*Mucorales*). 2th ed. Moscow and Lenningrad, Bot. Inst. Acad. Sci. U.R.S.S.

Nyberg Å, Persson IL. 2002. Habitat differences of coprophilous fungi on moose dung. Mycological Research 106 (11): 1360–1366.

Piontelli E, Santa-Maria MAT, Caretta G. 1981. Coprophilous fungi of the horse. Mycopathologia 74: 89–105.

Richardson MJ. 2001. Diversity and occurrence of coprophilous fungi Mycological Research 105: 387–402.

Tandon RN. 1968. *Mucorales* of India. India, New Delhi: Indian Council of Agricultural Research.

Trufem SFB. 1984. *Mucorales* do Estado de São Paulo. 4. Espécies coprófilas. Rickia 11: 65–75.

Viriato A, Trufem SFB. 1985. *Mucorales* do Estado de São Paulo. 5. *Pilobolaceae*. Rickia 12: 77–88.

Zheng RY, Hu FM. 1979. *Mucorales* of China. 1–1527, in FL Tai (ed.), Sylloge Fungorum Sinicorum. Beijing, Science Press.

Zycha H, Siepmann R, Linnemann G. 1969. *Mucorales*. Germany, J. Cramer.

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New graminicolous rust fungi from Pakistan

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Abstract — Two new species of rust fungi, *Puccinia agrostidis-caninae* on *Agrostis canina* and *P. sporoboli-arabici* on *Sporobolus arabicus* are described and illustrated from Pakistan.

Key words — Khanspur, Mukshpuri, *Poaceae*, *Puccinia striiformis*

Introduction

Efforts have been made recently to study and enumerate the rust fungi on *Poaceae* in Pakistan (Afshan et al. 2007). In Pakistan, the family *Poaceae* is represented by 158 genera and 492 species (Cope 1982). Of these, 130 species have been reported as hosts of more than 100 species of rust fungi, among them 53 species of *Puccinia* Pers. and 14 species of *Uromyces* (Link) Unger (Ahmad et al. 1997, Afshan et al. 2007).

During our study, *Agrostis canina* and *Sporobolus arabicus* were found infected with three different species of *Puccinia*, which appeared to be new to science. This paper describes these new species and compares them with similar rust fungi previously known on these grasses.

Materials and methods

Freehand sections of infected tissue and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a digipro-Labomed. Drawings of spores and paraphyses were made using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spore dimensions were taken by an ocular micrometer. At least 25 spores were measured for each spore stage. The arithmetic means are given after the ranges of measurements (in brackets). The rusted specimens have been deposited in the herbarium of the Botany Department, University of the Punjab, Lahore (LAH).

Enumeration of taxa

Puccinia agrostidis-caninae Afshan, Berndt, Khalid & Niazi, sp. nov.

MycoBank 511496 **(Figs. A-B, Table 1)**

Spermogonia et aecia ignota. Uredinia amphigena, subepidermalia, dilute brunnea. Urediniosporae globosae vel subglobosae; 15-21.5 × 19-24 μm (medium 18.8 × 19.4 μm); membrana 1.5-2 μm crassa, hyalinae vel flavidae, echinulatae; poris germinationis 1-4, aequatorialibus vel sub-aequatorialibus, pedicellis hyalinis, usque ad 5-6 × 15 μm. Telia amphigena, subepidermalia, atrobrunnea. Teliosporae 1-2 cellulares, ellipsoideae vel oblongae; brunneae vel castaneo-brunneae, basaliter pallidae, pariete levi, 2-3 μm crasso; bicellulares sporae 10-18 × 33-58 μm, unicellulares sporae 13-18 × 26-32 μm; apice conico, oblique conico vel truncato, 2.5-6.5 μm crasso; poro germinationis 1 per cellulam, sub-apicaliter in cellula distali, aequatorialis in cellula proximali; pedicello brunneo, usque ad 7 μm longo.

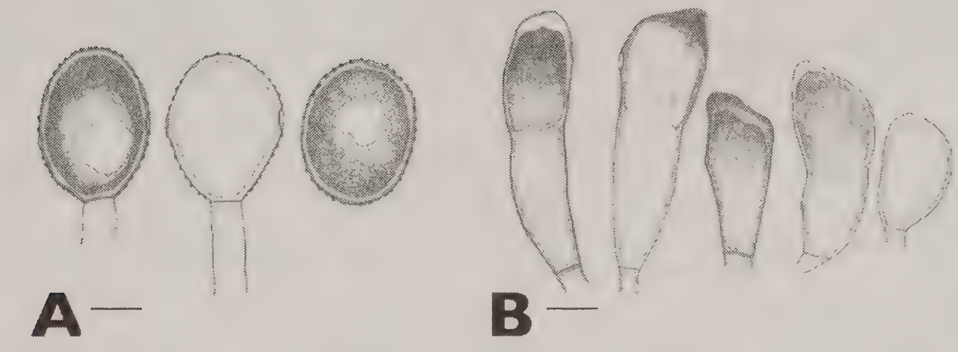
Holotype: On *Agrostis canina* L. with II and III stages, Pakistan, North Western Frontier Province (NWFP), Khanspur village, at 2575 m a.s.l., 15 September 2006. NSA # 15906. N. S. Afshan & A. N. Khalid. (LAH Herbarium No. NSA 1001).

Etymology: Named after the host plant *Agrostis canina*.

Spermogonia and aecia unknown. Uredinia amphigenous, subepidermal, light brown, 0.6-0.8 × 1.9-2.0 mm. Urediniospores globose to subglobose, 15-21.5 × 19-24 μm (mean 18.8 × 19.4 μm); wall 1.5-2 μm thick, hyaline to yellow, echinulate; germ pores 1-4, equatorial or sub-equatorial. Pedicel hyaline, 5-6 μm wide and up to 15 μm long. Telia amphigenous, subepidermal, dark brown, 0.4-0.7 × 0.6-0.8 mm. Teliospores 1-2 celled, ellipsoid-oblong; wall 2-3 μm thick, brown to chestnut brown but paler basally, smooth; two-celled spores 10-18 × 33-58 μm (mean 15.4 × 44.3 μm), one-celled spores 13-18 × 26-32 μm; apex conical or obliquely conical, sometimes truncate, 2.5-6.5 μm thick; germ pore 1 per a cell, in distal cell sub-apical and at the equator of the proximal cell; pedicel short, brown, up to 7 μm long.

Comments: Cummins (1971) reported ten *Puccinia* species on different species of *Agrostis*: *P. agrostidicola* F.L. Tai, *P. brachypodii* var. *poae-nemoralis* (G.H. Otth) Cummins & H.C. Greene, *P. coronata* Corda var. *coronata*, *P. coronata* var. *himalensis* Barclay, *P. graminis* subsp. *graminicola* Z. Urb., *P. pygmaea* Erikss., *P. poarum* E. Nielsen, *P. praegracilis* Arthur, *P. recondita* Roberge ex Desm., *P. striiformis* Westend., and two taxa belonging to the genus *Uromyces*, *U. dactylidis* var. *poae* (Rabenh.) Cummins, and *U. fragilipes* Tranzschel.

P. agrostidis-caninae is characterized by the presence of 1-2 celled teliospores with very short pedicels. Other characteristic features are the smaller size of the uredinio- and teliospores than in the rust fungi already known on *Agrostis* and



Figs. A-B: *Puccinia agrostidis-caninae* (type)
Lucida drawings of (A) urediniospores and (B) teliospores.
Scale bars = 10 μm.

the presence of 1-4 equatorial germ pores in the urediniospores. (A comparison of *Puccinia agrostidis-caninae* with similar species is presented in Table 1)

P. striiformis resembles *P. agrostidis-caninae* in having subepidermal telia, 1-2 celled smooth teliospores and echinulate urediniospores. However, *P. agrostidis-caninae* is different by smaller spores (urediniospores 15-22 × 19-24 μm vs. 15-26 × 20-34 μm, teliospores 10-18 × 26-58 μm vs. 12-26 × 30-70 μm). In addition, number and distribution of germ pores of urediniospores are different in the present species (1-4 equatorial germ pores vs. 9-15 scattered germ pores).

P. agrostidis-caninae resembles *P. brachypodii* var. *poae-nemoralis* by the wall ornamentation of urediniospores and the presence of 1-2 celled, smooth teliospores. But it can be separated from the latter on the basis of amphigenous uredinia and telia, 1-4 equatorial germ pores in urediniospores and absence of paraphyses. *P. brachypodii* var. *poae-nemoralis* has adaxial uredinia and abaxial telia, 8-12 scattered germ pores in the urediniospores and cylindrical-capitate paraphyses. Another difference that separates the two species are the smaller urediniospores (15-22 × 19-24 μm vs. 16-25 × 20-29 μm) and teliospores (10-18 × 26-58 μm vs. 14-25 × 31-64 μm) of the newly described *Puccinia* species.

P. agrostidis-caninae can be separated from *P. pygmaea* by the size of urediniospores and teliospores that are smaller (urediniospores 15-22 × 19-24 μm vs. 18-26 × 24-35 μm, teliospores 10-18 × 26-58 μm vs. 14-26 × 32-58 μm) in the present species. Additionally, *P. pygmaea* has urediniospores with 6-10 scattered germ pores and only two-celled teliospores.

P. recondita can be separated by the size of uredinio- and teliospores which are smaller in the present species: urediniospores 15-22 × 19-24 μm vs. 17-28 × 20-36 μm, teliospores 10-18 × 26-58 μm vs. 12-25 × 32-75 μm. In addition, *P. recondita* possesses 6-10, scattered germ pores in the urediniospores and only two-celled teliospores.

Table 1. Comparison of *Puccinia agrostidis-caninae* with similar *Puccinia* species.

Puccinia agrostidis-caninae	*Puccinia striiformis*	*Puccinia brachypodii* var. *poae-nemoralis*	*Puccinia pygmaea*	*Puccinia recondita*	*Puccinia poarum*
Uredinia					
amphigenous, subepidermal	adaxial or amphigenous, subepidermal	adaxial	unknown	often amphigenous	adaxial
Urediniospores					
globose-subglobose	broadly ellipsoid or broadly obovoid	ellipsoid-broadly ellipsoid or obovoid	ellipsoid, broadly ellipsoid or obovoid	broadly ellipsoid or obovoid	obovoid or ellipsoid
hyaline-yellow	pale yellow or nearly colorless	hyaline-pale golden	yellow-cinnamon brown	yellowish brown-cinnamon brown	colorless or pale yellow
echinulate	closely echinulate	closely echinulate	finely echinulate	echinulate	echinulate
germ pores					
1-4, equatorial or sub-equatorial	9-15, scattered, obscure	8-12, scattered, obscure	6-10, scattered, obscure	6-10, scattered	4-8, scattered
size					
15-21.5 x 19-24 µm	18-29 x 24-36 µm	16-25 x 20-29 µm	18-26 x 24-35 µm	17-28 x 20-36 µm	14-26 x 21-37 µm
paraphyses					
absent	cylindrical or saccate-capitate	cylindric-capitate,, 50-80 x 16–18 µm	capitate or clavate-capitate	unknown	capitate, short, few
Teliospores					
amphigenous, subepidermal, loculate	abaxial, subepidermal	abaxial, subepidermal	abaxial, sub-epidermal	abaxial or adaxial, subepidermal	abaxial, subepidermal
1-2 celled	1-2 celled	2-celled	2-celled	2-celled	2-celled
ellipsoid-oblong	oblong-clavate	unknown	oblong-obovoid or oblong	oblong-clavate	elongately obovoid or oblong-clavate
brown-chestnut brown; paler basally	deep golden brown or chestnut brown	chestnut brown or paler basally	unknown	chestnut brown	chestnut brown above, golden basally
10-18 x 26-58 µm	12-26 x 30-70 µm	14-25 x 31-64 µm	14-26 x 32-58 µm	12-25 x 32-75 µm	14-28 x 36-77 µm
apex thickness					
2.5-6.5 µm	3-10 µm	3-7 µm	2-6 µm	3-7 µm	2-8 µm
pedicel					
brown, ≤7 µm long	colorless-brownish, ≤20 µm long	colorless-brownish, <20 µm long	yellow, ≤15 µm long	brown, ≤ 20 µm long	colorless or yellow, ≤15 µm long

P. agrostidis-caninae has some resemblance with *P. poarum* by the one- to two-celled, smooth teliospores and echinulate urediniospores. But it can be separated by smaller uredinio and teliospores (urediniospores 15-22 × 19-24 µm vs. 14-26 × 21-37 µm, teliospores 10-18 × 26-58 µm vs. 14-28 × 36-77 µm). Another difference of *P. poarum* are urediniospores with 4-8 germ pores and the presence of capitate paraphyses.

Puccinia sporoboli-arabici Afshan, Berndt, Khalid & Niazi, **sp. nov.**

MycoBank MB 511498 **(Figs. C-D, Table 2)**

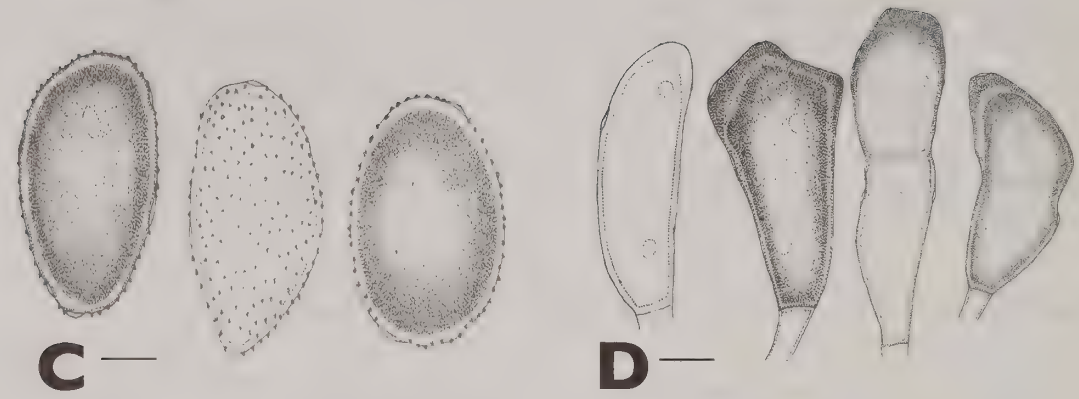
Spermogonia et aecia ignota. Uredinia in pagina adaxiali foliorum, brunnea. Urediniosporae globosae, ellipsoideae vel ovoideae, 17-21 × 20-24 µm (medium 18.7 × 21.7 µm); poris germinationis 2-5, obscurissimis, dispersis; membrana 1-1.5 µm crassa, hyalinae vel dilute flavidae, echinulatae. Telia abaxialia, subepidermalia, atra, striiformia, loculata, paraphysibus brunneis praedita. Teliosporae 1-2 cellulares, unicellulares rarae. Teliosporae bicellulares oblongae vel ellipsoideae, apicaliter castaneo-brunneae, basaliter pallidae, 12-20 × 31-52 µm (medium 15.0 × 40.5 µm), pariete levi, 1-1.5 µm crasso, apice 3-7 µm crasso, truncato vel conico; poro germinationis 1 per cellulam, obscurissimo; pedicello brunneo, 3-5 × 6-9 µm. Teliosporae unicellulares clavatae vel ellipsoideae, brunneae vel castaneo-brunneae, 12-14 × 22-33 µm; poro germinationis 1, obscurissimo; pariete 1-1.5 µm crasso, apice 2-7 µm crasso, truncato vel conico; pedicello brunneo, usque ad 5 µm longo. Paraphysibus raris, cylindricis vel clavatis, castaneo-brunneis, usque ad 50 µm longis.

Holotype: On *Sporobolus arabicus* Boiss. Pakistan, Northwest Frontier Province (NWFP.), Mukshpuri track, at 2813 m a.s.l., 16 September 2006. NSA # 169061. A. N. Khalid, N. S. Afshan & A. R. Niazi. (LAH Herbarium No. NSA 1003).

Etymology: Named after the host plant *Sporobolus arabicus*.

Spermogonia and aecia unknown. Uredinia adaxial on leaves, brown. Urediniospores globose to ellipsoid or ovoid, 17-21 × 20-24 µm (mean 18.7 × 21.7 µm); germ pores 2-5, obscure, scattered; wall 1-1.5 µm thick, hyaline to light yellow, echinulate. Telia abaxial, subepidermal, black, round to striate, 0.3-0.6 × 0.5-0.8 mm, loculate with few paraphyses surrounding the sorus. Teliospores mostly two-celled, one-celled teliospores rare. Two-celled teliospores oblong-ellipsoid, chestnut brown at the apex, paler basally, 12-20 × 31-52 µm (mean 15.0 × 40.5 µm), smooth, wall 1-1.5 µm at sides, 3-7 µm apically, apex truncate or conical; germ pores obscure; pedicel brown, short, 3-5 × 6-9 µm. One-celled teliospores clavate-ellipsoid, golden brown to chestnut brown, 12-14 × 22-33 µm; germ pores obscure; wall 1-1.5 µm thick at sides, 2-7 µm thick apically, apex truncate or conical; pedicel brown, up to 5 µm long. Paraphyses few, cylindrical-clavate, dark chestnut brown, up to 50 µm long.

Comments: Thirteen rust fungi already reported on *Sporobolus* spp. include ten taxa of *Puccinia*, viz. *P. arundinellae-setosae* F.L. Tai, *P. cryptandri* Ellis & Barthol. var. *cryptandri*, *P. cryptandri* var. *luxurians* (Arthur) Cummins & H.C. Greene, *P. graminis* subsp. *graminicola*, *P. kakamariensis* Wakef. & Hansf.,



Figs. C-D: *Puccinia sporoboli-arabici* (type)
Lucida drawings of (C) urediniospores and (D) one- and two-celled teliospores.
Scale bar = 5 µm.

P. schedonnardi Kellerm. & Swingle, *P. sporoboli* Arthur var. *sporoboli*, *P. sporoboli* var. *robusta* Cummins & H.C. Greene, *P. vilfae* Arthur & Holw. var. *vilfae*, *P. vilfae* var. *mexicana* Cummins, and three *Uromyces* spp., viz. *U. sporoboli* Ellis & Everh., *U. sporobolicola* J.C. Lindq., and *U. tenuicutis* McAlpine (Cummins 1971).

Puccinia sporoboli-arabici is characterized by the presence of 1-2-celled teliospores with a very short pedicel. The abaxial, subepidermal, loculate telia also make it different from other species of rust fungi already known from *Sporobolus* spp. (A comparison of *Puccinia sporoboli-arabici* with similar species is presented in Table 2)

P. sporoboli-arabici closely resembles *P. arundinellae-setosae* by the presence of 1-2 celled, smooth teliospores with a very short pedicel and echinulate urediniospores. It differs by longer teliospores (22-52 µm vs. 30-43 µm), shorter urediniospores (20-24 µm vs. 21-30 µm) and the presence of abaxial, subepidermal telia.

P. sporoboli-arabici has some characters in common with *P. sporoboli* including wall ornamentation of urediniospores and shape and size of teliospores. It can be separated by smaller urediniospores (17-21 × 20-24 µm vs. 20-32 × 24-32 µm), however. In contrast to *P. sporoboli-arabici*, *P. sporoboli* has only two-celled teliospores with longer (50 µm) pedicels.

P. kakamariensis resembles *P. sporoboli-arabici* on the basis of wall ornamentation and size of uredinio- and teliospores. It has amphigenous telia, however, with teliospore pedicels up to 150 µm long.

From *P. striiformis*, *P. sporoboli-arabici* differs by shorter urediniospores (20-24 µm vs. 20-34 µm), smaller teliospores (12-20 × 22-52 µm vs. 12-26 × 30-70 µm), and only up to five germ pores in the urediniospores.

P. sporoboli-arabici has smaller urediniospores (17-21 × 20-24 µm vs. 17-30 × 24-45 µm) than *P. cryptandri* and very short pedicels of the teliospores.

Table 2. Comparison of *Puccinia sporoboli-arabici* with similar *Puccinia* species.

Puccinia sporoboli-arabici	*Puccinia arundinellae-setosae*	*Puccinia sporoboli*	*Puccinia kakamariensis*	*Puccinia striiformis*	*Puccinia cryptandri*
Uredinia					
adaxial	amphigenous	amphigenous	amphigenous	amphigenous or adaxial	adaxial
Urediniospores					
globose-ellipsoid or ovoid	ovate or subglobose	broadly ellipsoid	pyriform or ellipsoid	broadly ellipsoid or obovoid-ellipsoid	ellipsoid or oblong
hyaline-light yellow	chestnut brown	cinnamon brown	colorless	unknown	yellowish-cinnamon brown
echinulate	echinulate	finely echinulate	finely echinulate	echinulate	coarsely echinulate
germ pores					
2-5, scattered, obscure	3-5, equatorial	3-4, scattered	3 or 4, equatorial	9-15, scattered	4-8, scattered or equatorial
size					
17-21 x 20-24 µm	18-21 x 21-30 µm	20-32 x 24-32 µm	16-22 x 18-27 µm	15-26 x 20-34 µm	17-30 x 24-45 µm
paraphyses					
paraphyses absent	capitate or clavate	absent	absent	cylindrical, saccate to capitate	unknown
Teliospores					
abaxial, subepidermal	amphigenous, pulvinate	amphigenous, soon exposed	amphigenous, pulvinate	abaxial, subepidermal	adaxial, pulvinate
1-2 celled oblong-ellipsoid or clavate	1-2 celled ellipsoid or ovate-oblong	2-celled oblong-ellipsoid or narrowly obovoid	2-celled ellipsoid or oblong-ellipsoid	1-2 celled oblong-clavate or oblong, variable	1-2 celled ellipsoid or oblong-ellipsoid
chestnut brown-paler basally	unknown	chestnut brown or paler below	chestnut brown	deep golden brown or chestnut brown	chestnut brown
size					
12-20 x 22-52 µm	16-21 x 30-43 µm	14-23 x 25-50 µm	18-28 x 25-47 µm	12-26 x 30-70 µm	22-36 x 32-56 µm
apex					
3-7 µm thick	2-4 µm	4-12 µm	3-8 µm	3-10 µm	4-10 µm
pedicel					
brown, ≤ 5 µm long	chestnut brown, short	yellowish, 50 µm long	near colorless, inserted obliquely, 150 µm long	colorless-brownish, ≤ 20 µm long	colorless, 125 µm long
paraphyses					
clavate, chestnut brown	unknown	unknown	unknown	brown	unknown

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References

Afshan NS, Khalid AN, Abbasi M, Niazi AR. 2007. New records of rust fungi for Pakistan. Mycotaxon 101: 233-237.

Ahmad S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Nabiza Printing Press, Karachi, Pakistan.

Cope TA. 1982. Flora of Pakistan, *Poaceae*. (Eds. E. Nasir, S. I. Ali). Shamim Printing Press, Karachi, Pakistan.

Cummins GB. 1971. The Rust Fungi of Cereals, Grasses and Bamboos. Springer Verlag Berlin-Heidelberg-New York.

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Two new species of *Doratomyces* from soil

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Abstract—Two new species of *Doratomyces, D. castaneus* and *D. verrucisporus*, both from soil in China are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words—taxonomy, soil fungi, dematiaceous hyphomycetes

Introduction

Until 2006, only seven species belonging to the genus *Doratomyces* Corda have been reported worldwide (http://www.indexfungorum.org/Names/ Names.asp). During an investigation of dematiaceous soil hyphomycetes in Guizhou Province, two fungi were obtained from a grassland soil and a mountain soil, respectively. Both match the characteristics of *Doratomyces* morphologically but differ from all described species in this genus; they are therefore described below as new.

Taxonomic descriptions

Doratomyces castaneus Y.L. Jiang & T.Y. Zhang, **sp. nov.** FIGURE 1
MycoBank MB 511506

Coloniae in PDA effusae, atrogriseae vel atrae, floccosae. Mycelium partem superficiale et partem immersum, ex hyphis ramosis, septatis, hyalinis, laevibus, 1-2.5 µm crassis reticulatis compositum. Synnemata 600-1600 µm alta, cum cylindricis et ellipsoideis capitis, stipites atro-brunnea, 10.5-24 µm crassa; celluae conidiogenae percurrentes (annellophora) 5.5-10.5 µm longa, basi tumidula 3-4.5 µm diam., quae in zonam annellatam, 1-2 µm diam. Conidia sphaerica vel subsphaerica, laevibus, parietes crassa , 4-6 µm diam., castanea, fuliginea universa.

Holotype: from a grassland soil of Huaxi Park in Guiyang, Guizhou Province, China. Oct. 6. 2005, Y.L. Jiang, HSAUP051034.

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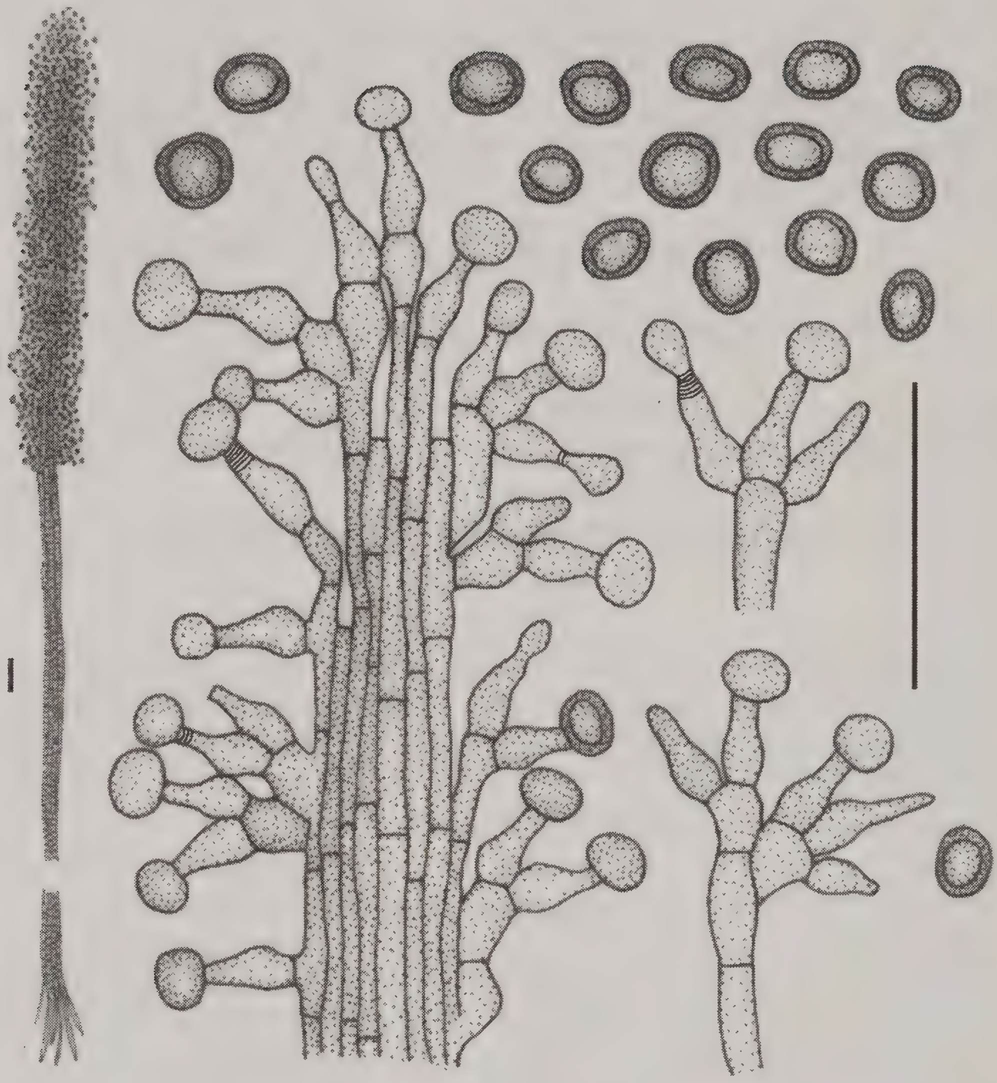

Fig. 1 Conidia, conidiogenous cells and synnema of *Doratomyces castaneus* (ex holotype; bar=25 µm)

Etymology: in reference to the nut-brown coloured conidia of this species

Colonies on PDA effuse, at first buff, central sporulating area pale grey, the grey colour spreading and darkening to blackish, finally dark grey to black with the formation of abundantly sporing structures and synnemata, the margin white velvety during the growing period, floccose. Mycelium partly superficial, partly immersed: hyphae branched, septate, hyaline, smooth, 1-2.5 µm wide. Synnemata 600-1600 µm high, with cylindrical or ellipsoidal heads, stipes blackish brown, 10.5-24 µm wide; conidiogenous cells (annellophores) 5.5-10.5 µm long, swollen base 3-4.5 µm diam, tapering abruptly into the annellated zone 1-2 µm diam. Conidia spherical or subspherical, smooth, thick-walled, 4-6 µm diam, nut-brown, blackish brown in mass.

Doratomyces castaneus is distinguished from all described species of *Doratomyces* by its spherical or subspherical, thick-walled, and nut-brown conidia.

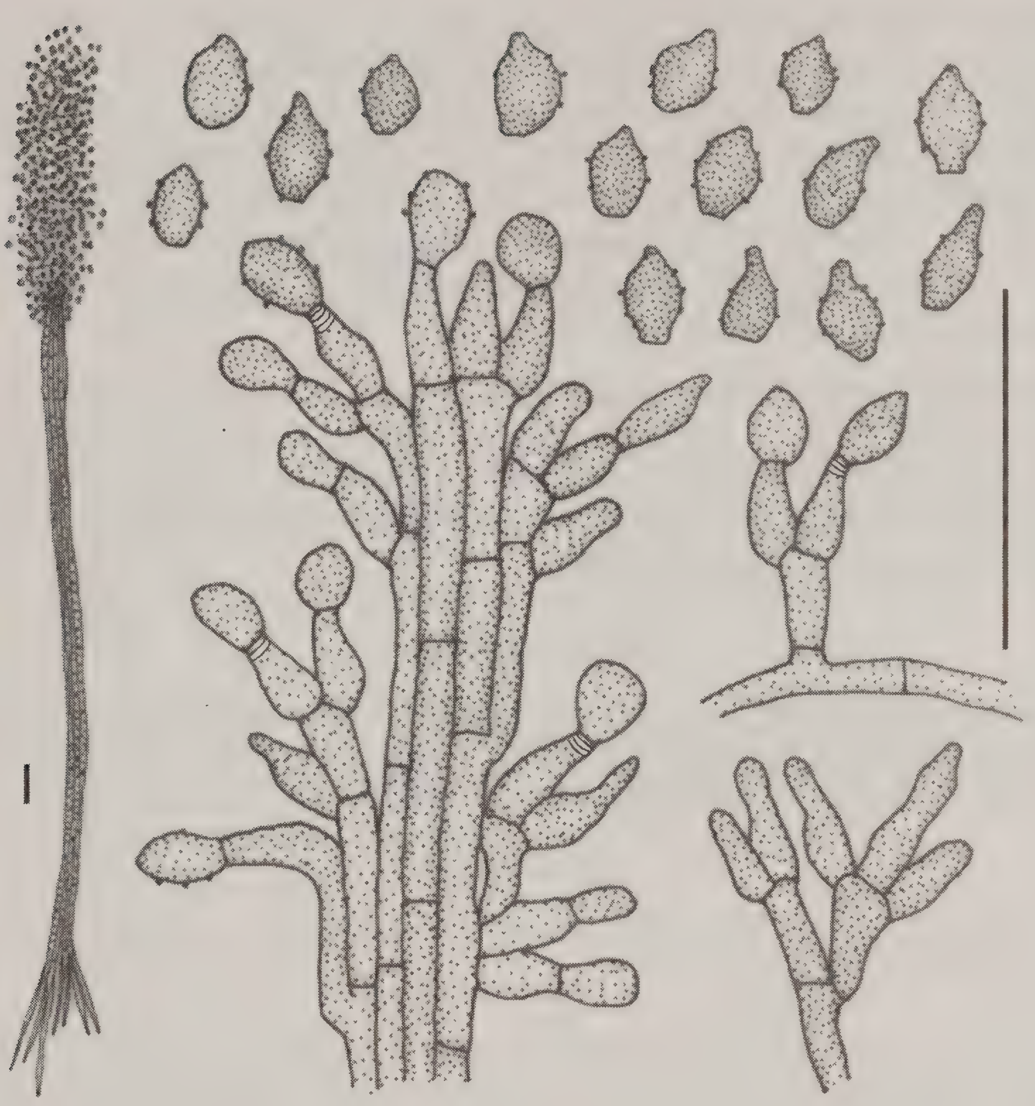

Fig. 2 Conidia, conidiogenous cells and synnema of *Doratomyces verrucisporus* (ex holotype; bar=25 µm)

Doratomyces verrucisporus Y.L. Jiang & T.Y. Zhang, **sp. nov.** FIGURE 2
MycoBankMB 511507

Coloniae in PDA effusae, atrae, floccosae. Mycelium partem superficiale et partem immersum, ex hyphis ramosis, septatis, hyalinis, laevibus, 1.5-3.5 µm crassis reticulatis compositum. Synnemata usque ad 900 µm alta, cum cylindricis capitulis, stipites atro-brunnea, 7-27 µm crassa; celluae conidiogenae percurrentes (annellophora) 5-9.5 µm longa, basi tumidula 2.5-3.5 µm diam., quae in zonam annellatam, 1-2.5 µm diam. Conidia ovoidea, , basin truncata et apicem plerumque acuta, verrucosa, 6-9×3-5.5 µm, brunnea, atro-brunnea universa.

Holotype: from a mountain soil of Huaxi Park in Guiyang, Guizhou Province, China. Oct. 6. 2005, Y.L. Jiang, HSAUP051029.

Etymology: in reference to the verrucose conidia of this species

Colonies on PDA effuse, at first buff, central sporulating area pale grey, the grey colour spreading and darkening to blackish, finally black with the formation of abundantly sporing structures and synnemata, the margin white velvety during the growing period, floccose. Mycelium partly superficial, partly immersed, hyphae branched, septate, hyaline, smooth, 1.5-3.5 µm wide. Synnemata up to 900 µm tall, with cylindrical heads, stipes blackish brown, 7-27 µm wide; conidiogenous cells (annellophores) 5-9.5 µm long, swollen base 2.5-3.5 µm diam, tapering abruptly into the annellated zone 1-2.5 µm diam. Conidia ovoid, base truncate and usually distinctly pointed at the apex, verrucose, 6-9×3-5.5 µm, brown, blackish brown in mass.

The species most similar to this new fungus in conidial morphology is *Doratomyces nanus* F.J. Morton & G. Smith (Morton & Smith 1963). However, *D. nanus* conidia are wider (4-7 µm) than those of *D. verrucisporus*. Also, the conidia of *D. nanus* have a rounded or bluntly pointed apex, while those of the present fungus are distinctly pointed.

Acknowledgments

The authors are grateful for pre-submission comments and suggestions provided by Dr. B. Kendrick, Prof. Y. L. Guo and Dr. Shaun Pennycook. This project was supported by the National Science Foundation of China (no.30570005, 30499340).

Literature cited

Morton FJ, Smith G. 1963. The genera *Scopulariopsis* Bainier, *Microascus* Zukal, and *Doratomyces* Corda. Mycol. Pap. 86: 80-82.

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New species of *Bipolaris*, *Scolecobasidium* and *Torula* from soil

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Abstract—Three new species of dematiaceous hyphomycetes: *Bipolaris fusca*, *Scolecobasidium laeve* and *Torula brunnea*, isolated from soil in China, are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words—taxonomy, soil fungi

Introduction

Three new dematiaceous hyphomycetes isolated from soils of Sichuan Province in China are described and illustrated. They belong to the genera of *Bipolaris*, *Scolecobasidium* and *Torula*. Until 2006, 100 taxa of *Bipolaris*, 39 taxa of *Scolecobasidium* and about 400 taxa of *Torula* have been reported in the world (http://www.indexfungorum.org/Names/Names.asp).

Taxonomic descriptions

Bipolaris fusca Y.L. Jiang & T.Y. Zhang, **sp. nov.** FIGURE 1

MycoBank MB 511514

Coloniae in agaro TWA+W effusae, velutinae, griseo-brunneae. Mycelium partem superficiale et partem immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 2-4 µm crassis reticulatis compositum. Conidiophora recta vel flexuosa, simplicia vel fasciculata, laevia, flavo-brunnea, versus apicem pallidiora, geniculata, multiseptata, 75-150×3-8 µm. Conidia acropleurogena, plerumque curvata, laevibus, cylindrica vel ellipsoidea, flavo-brunnea vel atro-brunnea, cellulae tremitatibus pallidiora, ad densa atra distosepta separantia, 3-11-distoseptata, pro maxima parte 5-7 transverse septata, 31-67×11-20 µm.

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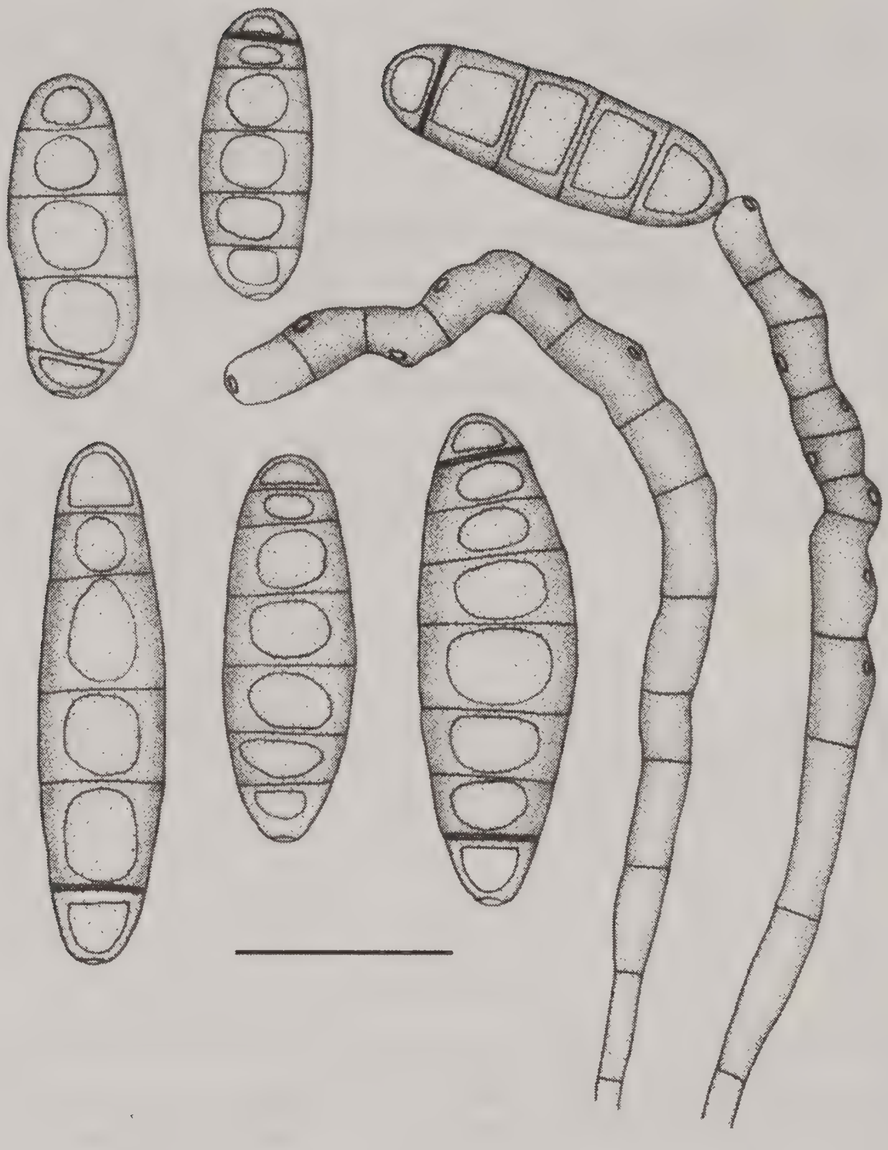

Fig. 1 Conidia and conidiophores of *Bipolaris fusca*
(ex holotype; bar=25 μm)

Holotype: from a grassland and shrub soil of Batang, Sichuan Province, China. Jun. 28. 2006, Y.L. Jiang, HSAUP069079.

Etymology: in reference to the brown conidia

Colonies in tap water agar+wheat straw (TWA+W) effuse, velvety, greyish brown, growing sparsely but rapidly, reaching 5-7 cm in diameter at 25°C in one week. Mycelium partly superficial, partly immersed, hyphae branched, septate, pale brown, smooth, 2-4 μm wide. Conidiophores straight or flexuous, simple, rarely branched, smooth, yellowish brown, paler towards the apex, often geniculate at upper parts, multiseptate, 75-150×3-8 μm. Conidia acropleurogenous, straight or occasionally slightly curved, smooth, cylindrical or ellipsoidal, yellowish brown to dark brown, end cells often very pale and cut off by thick, dark septa, 3-11- (commonly 5-7) distoseptate, 31-67×11-20 μm.

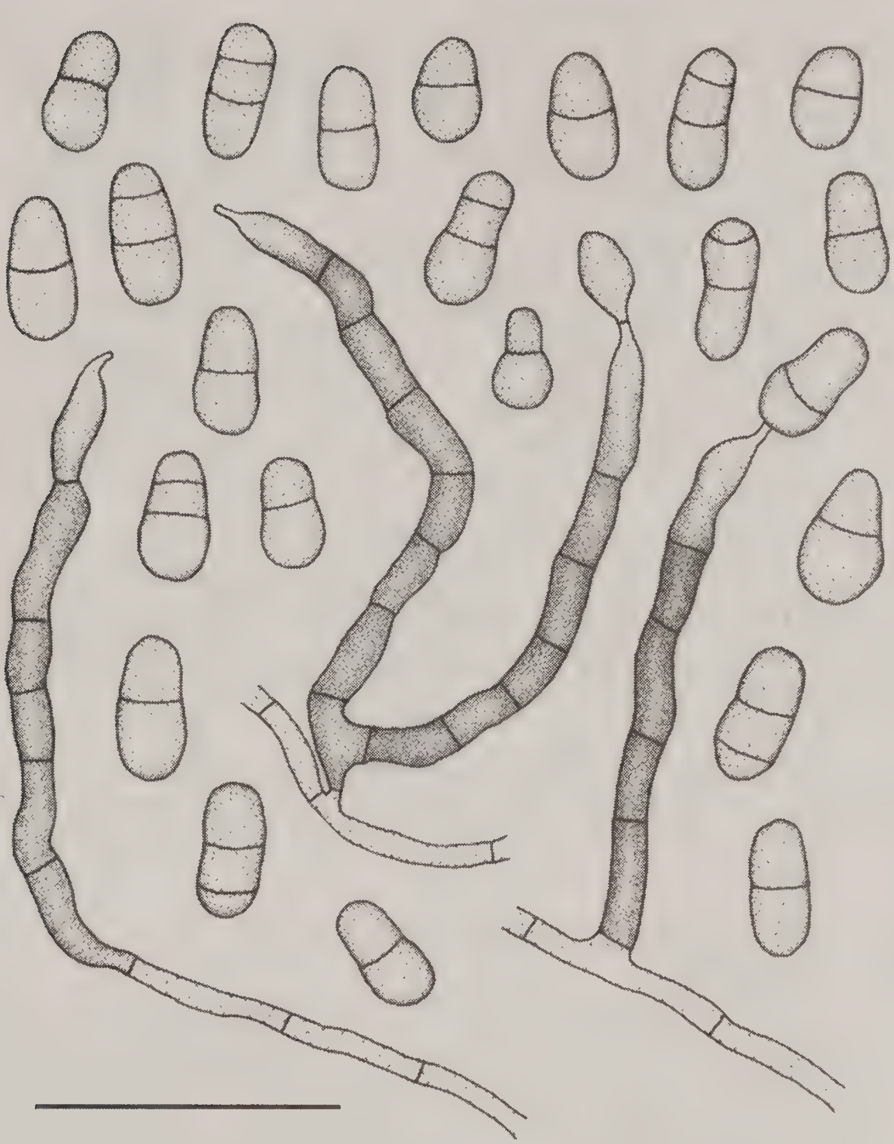

Fig. 2 Conidia and conidiophores of *Scolecobasidium laeve*
(ex holotype; bar=25 µm)

Bipolaris fusca is similar to *B. chinensis* G.Y. Sun & T.Y. Zhang (Sun & Zhang 1995) in conidial morphology. However, the conidia of *B. fusca* are smaller than those of *B. chinensis* (54-84×18-25 µm). In addition, the color of the conidiophores of the new taxon is darker than that of *B. chinensis* (pale yellow).

Scolecobasidium laeve Y.L. Jiang & T.Y. Zhang, **sp. nov.** FIGURE 2

MycoBank MB 511515

Coloniae effusae, in PDA crescentes lentissime et attingentes diametrum 2-3 centimetri ad 25°C post duas hebdomadas, centro paulo elevatae, velutina, olivaceo-brunneae. Mycelium plerumque superficialibus, e hyphis septatis, ramosis, laevibus, pallide brunneis, 1-2.5 µm crassis reticulatis compositum. Conidiophora macronematosa, mononematosa, interdum ramosa, recta vel flexuosa, septata, pallide brunnea vel atro-brunnea, brunnea vel atro-brunnea ad basim, apicem versus subhyalinis vel pallide brunnea, 15-63×2.5-5 *µm. Cellulae conidiogenae monoblasticae, in conidiophoris incorporatae, terminales, denticulatae, denticulatis cylindricis, brevibus praeditae. Conidia acrogena, solitaria, pyriformia, obclavata vel cylindrica, 1-2-septata, constricta ad septa, laevibus, pallide brunnea, 6-13×4-7.5 µm.*

Holotype: from a forest soil of Kangding, Sichuan Province, China. Jun. 25. 2006, Y.L. Jiang, HSAUP069024.

Etymology: in reference to the smooth-walled conidia

Colonies effuse, on PDA growing very slowly reaching a diameter of 2-3 cm after two weeks at 25°C, centre slightly raised, velvety, olivaceous brown. Mycelium mostly superficial. Hyphae septate, branched, smooth-walled, pale brown, 1-2.5 µm wide. Conidiophores macronematous mononematous, sometimes branched, straight or flexuous, septate, pale brown to dark brown, brown or dark brown at the base, subhyaline to pale brown at the tip, 15-63×2.5-5 µm. Conidiogenous cells monoblastic, integrated, terminal, denticulate, mostly with single, cylindrical, very short denticles. Conidia acrogenous, solitary, pyriform, obclavate or cylindrical, 1-2- septate, usually constricted at the septa, smooth, pale brown, 6-13×4-7.5 µm.

This new taxon differs from all previously described species in the genus in its smooth-walled, 1-2 septate, and pyriform, obclavate or cylindrical conidia.

Torula brunnea Y. L. Jiang & T. Y. Zhang, sp. nov. FIGURE 3

MycoBank MB 511516

Coloniae in PDA effusae, velutinae, griseae vel atrae. Mycelium superficiale vel immersum, ex hyphis ramosis, septatis, hyalinis, laevibus, 1-3 µm crassis reticulatis compositum. Conidiophora 2-4 µm crassis, subhyalina vel pallide brunnea, laevia, echinulata vel verrucosa, cellulae conidiogenae 4-8 µm diametro, sphaerica vel subsphaerica. Conidia recta vel leviter curvata, cylindrica, in extremitatibus rotundata, medio-brunnea vel atro-brunnea, echinulata vel verrucosae, 1-4-septata, pro maxima parte 2-3 septata, constricta ad septa, 9-21×5-7.5 µm.

Holotype: From a mountain soil of Luding, Sichuan Province, China. Jun. 24. 2006, Y.L. Jiang, HSAUP069074.

Etymology: in reference to the brown conidia

Colonies on PDA effuse, velvety, grey to black. Mycelium superficial or immersed, hyphae branched, septate, hyaline, smooth, 1-3 µm wide. Conidiophores 2-4 µm thick, except for the spherical or subspherical conidiogenous cells which are 4-8 µm diam, subhyaline to pale brown, smooth, echinulate or verrucose. Conidia straight or slightly curved, cylindrical, rounded at the ends, medium brown to dark brown, echinulate or verrucose, 1-4- (commonly 2-3) septate, constricted at the septa, 9-21×5-7.5 µm.

This species is similar to *Torula herbarum* f. *quaternella* Sacc. in conidial morphology. However, the conidia of the latter have fewer (1-3, commonly 2)

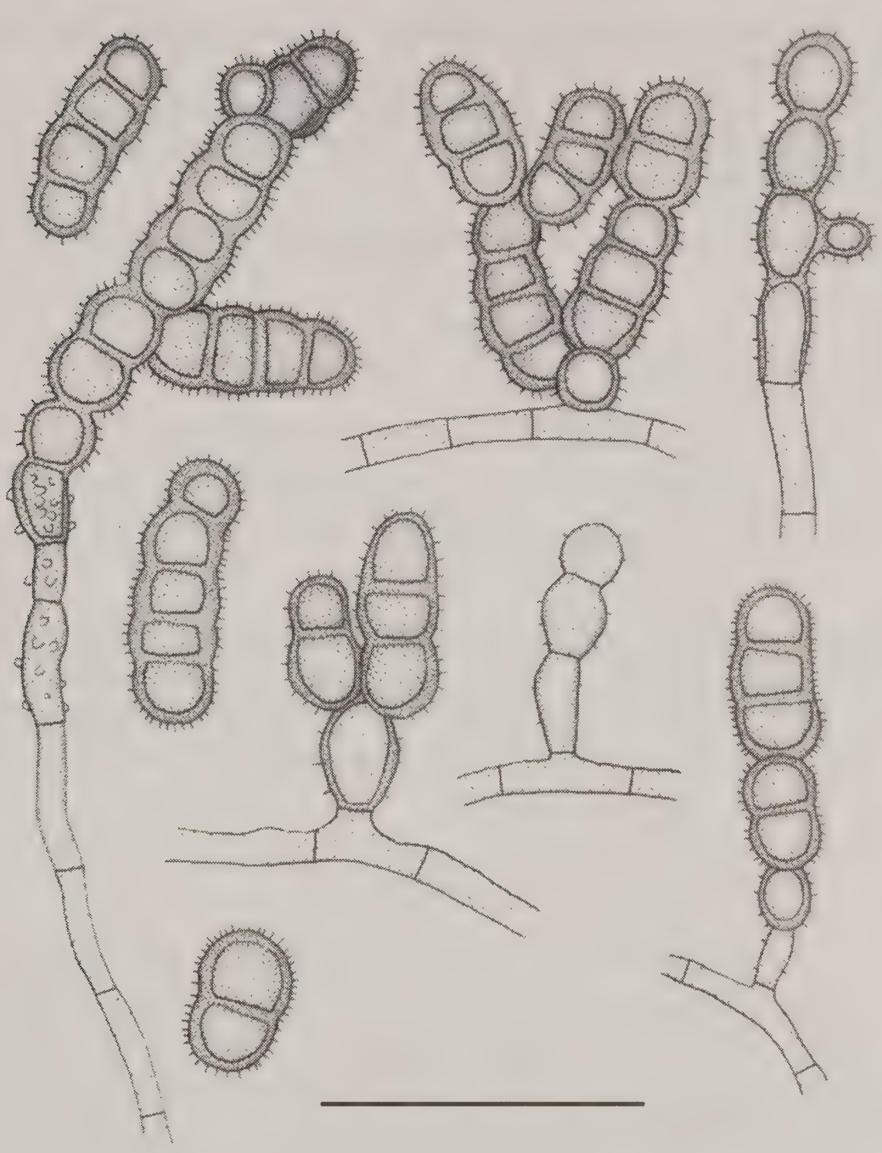

Fig. 3 Conidia and conidiophores of *Torula brunnea*
(ex holotype; bar=25 µm)

septa and are shorter (10-17 µm) (Ellis 1971) than those of the new taxon. In addition, the conidia of *T. herbarum* f. *quaternella* are almost smooth, but those of *T. brunnea* are echinulate or verrucose.

Acknowledgments

The authors are grateful for pre-submission comments and suggestions provided by Dr. B. Kendrick, Prof. Y. L. Guo and Dr. Shaun Pennycook. This project was supported by the National Science Foundation of China (no.30570005, 30499340).

Literature cited

Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England. 1-608.

Ellis MB. 1976. More dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England. 1-507.

Sun GY, Zhang TY. 1995. New species and new records for China in the genus *Bipolaris.* In Tan W. Z. (ed.). Research advances of young and middle-aged Chinese mycologists. South-West Normal University Press. 28-30.

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Two new *Ellisembia* species from Hainan, China

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Abstract—*Ellisembia artocarpi* sp. nov. and *E. sapii* sp. nov. were collected on dead branches from tropical forest in Hainan province. They are described, illustrated, and compared with similar taxa.

Key words—hyphomycetes, dematiaceous

Introduction

Ellisembia Subram. was segregated from *Sporidesmium* Link by Subramanian (1992), who transferred some previously described species of *Sporidesmium* into *Ellisembia*, which has monoblastic, integrated, terminal, determinate or percurrently extending conidiogenous cells on simple, non-extending or irregularly percurrently extending conidiophores, and cylindrical, obclavate, rostrate, fusiform, or narrowly clavate, obovoid, distoseptate, solitary conidia which occasionally have an appendage at the apex. Within this concept, the genus *Ellisembia* differs from other similar genera including *Repetophragma* Subram., *Stanjehughesia* Subram., *Sporidesmiella* P.M. Kirk, *Penzigomyces* Subram. and *Polydesmus* Mont., and all other segregates from *Sporidesmium*. At present, *Ellisembia* includes 34 valid species, 17 of which were transferred from *Sporidesmium* (Subramanian 1992, Wu & Zhuang 2005). Most species are reported to survive saprophytically on dead branches, twigs and wood, etc. Of the total, 26 species of *Ellisembia* have been reported from China (Wu & Zhuang 2005).

A survey of the saprobic fungi on dead wood from tropical forest in Hainan province, China revealed two previously undescribed species of *Ellisembia*.

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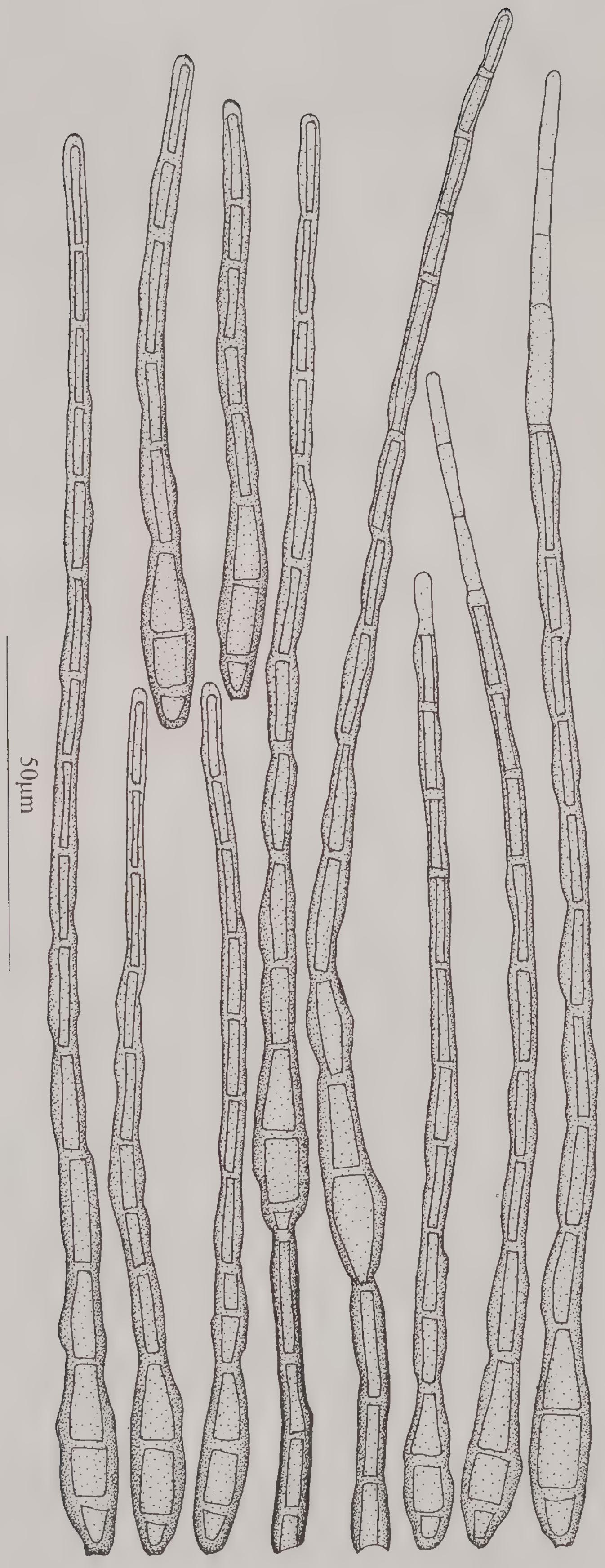

Fig. 1 Conidia and conidiophores of *E. artocarpi*

Taxonomic descriptions

Ellisembia artocarpi Jian Ma & X.G. Zhang, **sp. nov.** FIGURE 1

MycoBank MB 511517

Coloniae effusae, brunneae, pilosae. Mycelium partim superficiale, partim immersum in substrato, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 2-5 µm crassis compositum. Conidiophora macronematosa, mononematosa, singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter flexuosa, cylindrica, brunnea, septata, 30-90 µm longa, 3-4 µm crassa. Conidia holoblasticae, solitaria, acrogena, recta vel leviter curvata, obclavata, ad longe rostrata, laevia, pallide brunnea, 9-15-pseudoseptate, 88-220 µm longa, 7.5-9 µm crassa, apicem versus ad 2-3.5 µm attenuata, basi 2-3 µm lata.

Holotype: On dead branches of *Artocarpus styracifolius* Pierre, tropical forest of Jianfengling, Hainan Province, China. May. 2007, J. Ma, HSAUPVII$_{0MJ}$0106-1.

Etymology: in reference to the host, *Artocarpus styracifolius*

Colonies effused, brown, hairy. Mycelium partly superficial and partly immersed in the substratum, composed of branched, septate, pale brown, smooth-walled hyphae, 2-5 µm thick. Conidiophores macronematous, mononematous, singly or in groups, terminally and laterally on the hyphae, erect, simple, straight or slightly flexuous, cylindrical, brown, septate, 30-89 µm long, 3-4 µm thick. Conidia holoblastic, solitary, acrogenous, straight or slightly curved, obclavate to long-rostrate, smooth-walled, pale brown, 9-15-pseudoseptate, 88-220 µm long, 7.5-9 µm thick in the broadest part, tapering to 2-3.5 µm near the apex, 2-3 µm wide at the base.

In conidial morphology, this species resembles *E. britannica* (B. Sutton) W.P. Wu (Wu & Zhuang 2005). However, the conidia of *E. artocarpi* are larger than those of *E. britannica* (50-130 × 3-5 µm). In addition, the width of conidial bases in *E. artocarpi* (2-3 µm) is significantly narrower than that of *E. britannica* (3-4 µm).

Ellisembia sapii Jian Ma & X.G. Zhang, **sp. nov.** FIGURE 2

MycoBank MB 511518

Coloniae effusae, brunneae, pilosae. Mycelium partim superficiale et partim immersum in substrato, ex hyphis ramosis, septatis, pallide brunneis, levibus, 2-4.5 µm crassis compositum. Conidiophora macronematosa, mononematosa, singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter flexuosa, cylindrica, brunnea, septata, 36-59 µm longa, 4-5.5 µm crassa. Conidia holoblasticae, solitaria, acrogena, recta vel leviter curvata, angustuser obclavata, ad longe rostrata, laevia, pallide brunnea, 11-23- pseudoseptate, 95-240 µm longa, 6.5-7.5 µm crassa, apicem versus ad 3-4.5 µm attenuata, basi 3-4 µm lata.

Holotype: On dead branches of *Sapium sebiferum* (L.) Roxb., tropical forest of Jianfengling, Hainan Province, China. May. 2007, J. Ma, HSAUPVII$_{0MJ}$0106-3.

Etymology: in reference to the host, *Sapium sebiferum*

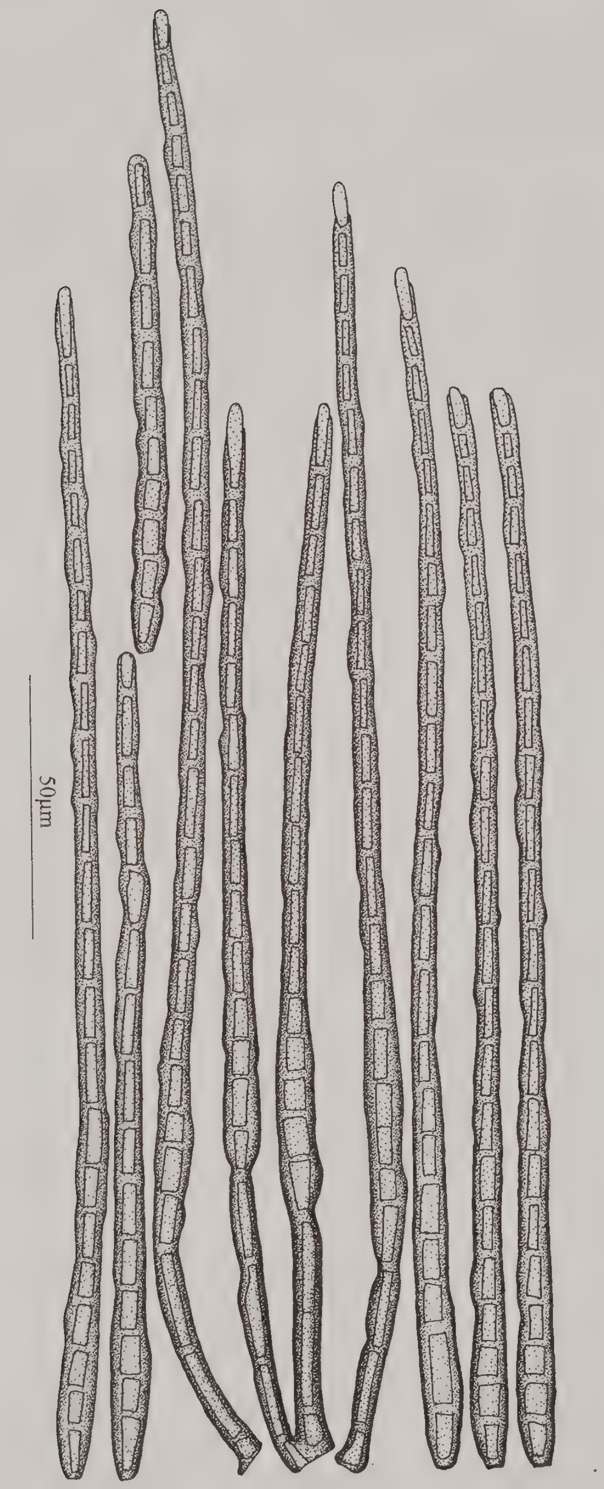

Fig. 2 Conidia and conidiophores of *E. sapii*

Colonies effused, brown, hairy. Mycelium partly superficial and partly immersed in the substratum, composed of branched, septate, pale brown, smooth-walled hyphae, 2-4.5 μm thick. Conidiophores macronematous, mononematous, singly or in groups, terminal and lateral on the hyphae, erect, simple, straight or slightly flexuous, cylindrical, brown, septate, 36-59 μm long, 4-5.5 μm thick.

Conidia holoblastic, solitary, acrogenous, straight or slightly curved, narrowly obclavate to long-rostrate, smooth-walled, pale brown, 11-23-pseudoseptate, 95-240 µm long, 6.5-7.5 µm thick in the broadest part, tapering to 3-4.5 µm near the apex, 3-4 µm wide at the base.

The conidia of *E. sapii* are similar to *E. britannica* (B. Sutton) W.P. Wu (Wu & Zhuang 2005) in shape. However, the conidia of *E. sapii* are larger than those of *E. britannica* (50-130 × 3-5 µm). In addition, the conidia of this species have more pseudosepta (11-23) than those of *E. britannica* (10-13).

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Literature cited

Subramanian CV. 1992. A reassessment of *Sporidesmium* (Hyphomycetes) and some related taxa. Proc. Indian natn. Sci. Acad. B58 (4): 179-190.

Wu WP, Zhuang WY. 2005. *Sporidesmium*, *Endophragmiella* and related genera from China. Fungal Diversity Research Series 15: 1-351.

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Two new species of the genus *Minimelanolocus* in China

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Abstract — Two new species of *Minimelanolocus,* viz. *M. endospermi* and *M. pterocarpi* occurred on the hosts *Endospermum chinense* and *Pterocarpus indicus,* respectively. They are described and illustrated here. The specimens of both taxa were collected from tropical forest in the south of China.

Key words — hyphomycetes, dematiaceous

Introduction

Castañeda et al. (2001) re-examined all of species of *Pseudospiropes* M.B. Ellis (Ellis 1971) comparing with the type species, *P. nodosus* in the morphology of conidiogenous loci and conidial septation. They then erected the segregate genus *Minimelanolocus* R.F. Castañeda & Heredia with *M. navicularis* as its type. The generic characteristics of *Minimelanolocus* as described originally by Castañeda et al. (2001) include holoblastic, polyblastic, indeterminate, terminal becoming intercalary, integrated conidiogenous cells with holoblastic sympodial extensions and inconspicuous or slightly prominent, narrow, opaque, refractive to somewhat obscure dehiscence scars, and euseptate conidia. Those characters also separate this genus from two other similar genera: *Nigrolentilocus* R.F. Castañeda & Heredia and *Matsushimiella* R.F. Castañeda & Heredia. As presently constituted, only 13 taxa of *Minimelanolocus* have been accepted from all over the world, and no species have been reported from China.

In our studies on hyphomycetes from deciduous stems or rotten wood in south of China, two previously undescribed species of *Minimelanolocus* were found. Evidently this genus is reported from China for the first time.

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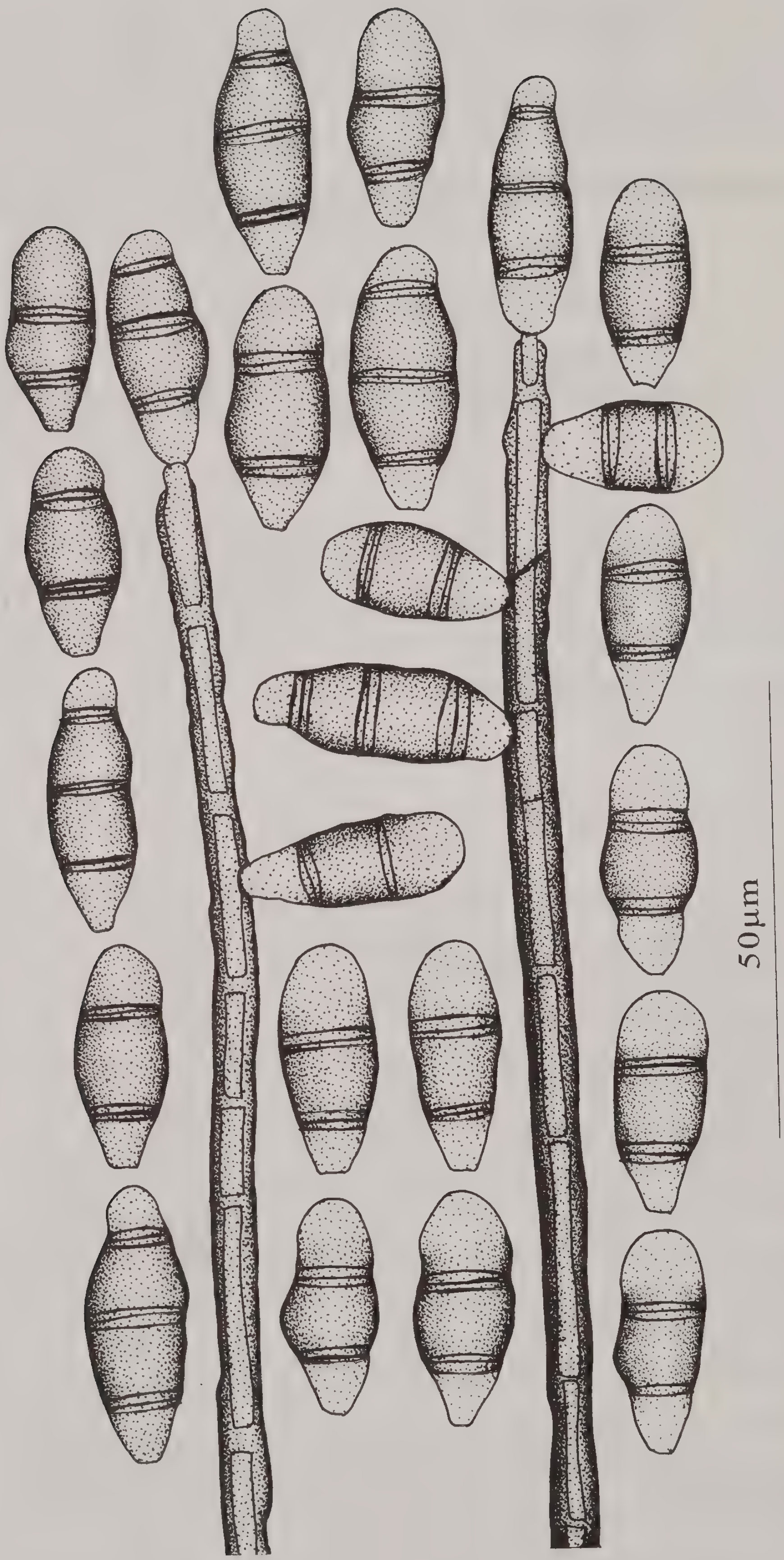

Fig. 1 Conidia and conidiophores of *Minimelanolocus endospermi*

Taxonomic descriptions

Minimelanolocus endospermi Jian Ma & X.G. Zhang, **sp. nov.** FIGURE 1
MycoBank MB 511519

Coloniae effusae in substrato naturali, olivaceo-brunneae vel fuscae, pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunnea vel brunnea, laevibus, 1.5-2.5 µm crassis compositum. Conidiophora macronematosa, mononematosa, singula, interdum caespitosa, nonramosa, erecta, recta vel flexuosa, laevia, brunnea, apice versus pallidiora, 7-11-septata, 160-260 µm longa, 3.5-6 µm crassa. Cellulae conidiogenae holoblasticae, polyblasticae, in conidiophoris incorporatae, indeterminatae, sympodialiter extendentes, terminales deinde intercalares, pallide brunneae. Loci conidiogeno inconspicuo vel leviter prominentibus, refractivi. Conidiorum secessio schizolytica. Conidia solitaria, acropleurogena, simplicia, ellipsoidea vel cylindrica, basi truncata, pallide brunnea vel brunnea, laevia, plerumque 2-euseptata, raro 3-euseptata, 20 -30 µm longa, 9-12 µm crassa, basi truncata 2-3 µm lata.

Holotype: On dead branches of *Endospermum chinense* Benth., tropical forest of Jianfengling, Hainan Province, China. May. 2007, J. Ma, HSAUPVII$_{0MJ}$0115-1.

Etymology: in reference to the host, *Endospermum chinense*

Colonies effused on the natural substratum, olivaceous brown to blackish brown, hairy. Mycelium partly superficial and partly immersed, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 1.5-2.5 µm thick. Conidiophores macronematous, mononematous, single, sometimes caespitose, unbranched, erect, straight or flexuous, smooth, brown, paler toward the apex, 7-11-septate, 160-260 µm long, 3.5-6 µm thick. Conidiogenous cells holoblastic, polyblastic, integrated, indeterminate, sympodially extending, terminal becoming intercalary, pale brown. Conidiogenous loci inconspicuous or slightly prominent, refractive. Conidial secession schizolytic. Conidia solitary, acropleurogenous, simple, ellipsoidal or cylindrical, truncate at the base, pale brown to brown, smooth-walled, mostly 2-euseptate, rarely 3-euseptate, 20-30 µm long, 9-12 µm thick in the broadest part, 2-3 µm wide at the truncate base.

The conidia of this species are similar to *M. bambusae*, *M. hughesii* and *M. leptotrichus* (Castañeda et al. 2001). However, the conidia of *M. endospermi* are larger than those of *M. bambusae* (15-19 × 6-7 µm), *M. hughesii* (12-18 × 4.5-6 µm) and *M. leptotrichus* (16-22 × 7-10 µm). In addition, the mature conidia of this taxon have 2-3 eusepta (mostly 2) while *M. bambusae* and *M. hughesii* have 3-4 (mostly 3), and *M. leptotrichus* has only 3.

Minimelanolocus pterocarpi Jian Ma & X.G. Zhang, **sp. nov.** FIGURE 2
MycoBank MB 511520

Coloniae effusae in substrato naturali, atro-brunneae, pilosae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 2.5-3.5 µm crassis compositum. Conidiophora macronematosa, mononematosa, solitaria, nonramosa, erecta, recta vel flexuosa, laevia, atro-brunnea, apice versus pallidiora, 5-12-septata, 130-

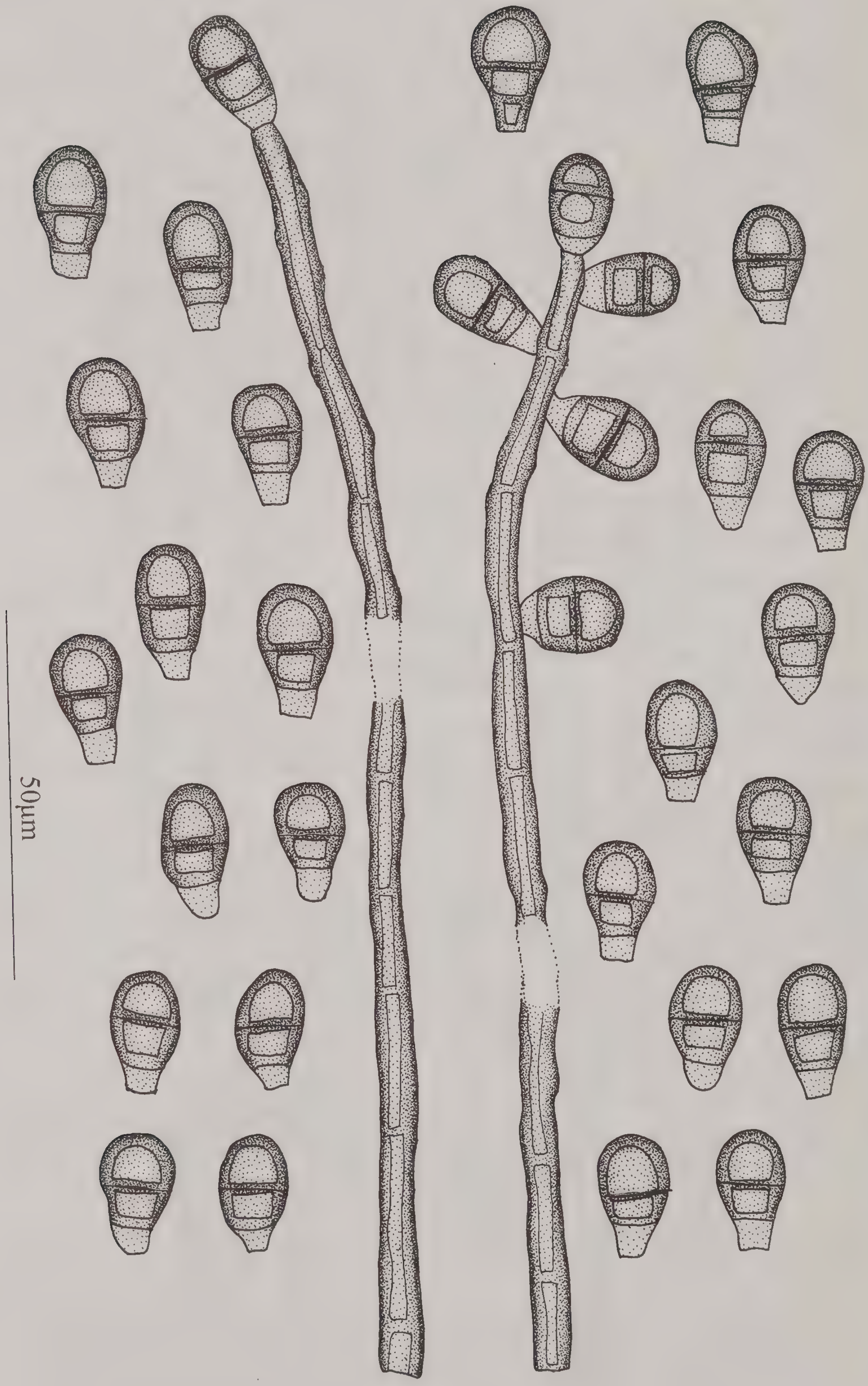

Fig. 2 Conidia and conidiophores of *Minimelanolocus pterocarpi*

240 µm longa, 4.5-6.5 µm crassa. Cellulae conidiogenae holoblasticae, polyblasticae, in conidiophoris incorporatae, indeterminatae, sympodialiter extendentes, terminales deinde intercalares, brunnea. Loci conidiogeno inconspicuo vel leviter prominentibus, subobscurus. Conidiorum secessio schizolytica. Conidia solitaria, acropleurogena, simplicia, obovata, apice rotundata, ad basim truncata, brunnea, cellula basali subhyalina vel pallide brunnea, laevia, 2-euseptata, 15-18 µm longa, 8.5-10 µm crassa. Basi truncata 2.8-4 µm lata.

HOLOTYPE: On dead branches of *Pterocarpus indicus* Willd., tropical forest of Hekou, Yunnan Province, China. May. 2003, X.G. Zhang, HSAUPIII$_{0zhxg}$0370-1.

ETYMOLOGY: in reference to the host, *Pterocarpus indicus*

Colonies effused on the natural substratum, dark brown, hairy. Mycelium partly superficial and partly immersed, composed of branched, septate, pale brown, smooth-walled hyphae, 2.5-3.5 µm thick. Conidiophores macronematous, mononematous, solitary, unbranched, erect, straight or flexuous, smooth, dark brown, paler toward the apex, 5-12-septate, 130-240 µm long, 4.5-6.5 µm thick. Conidiogenous cells holoblastic, polyblastic, integrated, indeterminate, sympodially extending, terminal becoming intercalary, brown. Conidiogenous loci inconspicuous or slightly prominent, somewhat obscure. Conidial secession schizolytic. Conidia solitary, acropleurogenous, simple, obovate, apex rounded, base truncate, brown except for the basal cell which is subhyaline or pale brown, smooth-walled, 2-euseptate, 15-18 µm long, 8.5-10 µm thick in the broadest part, 2.8-4 µm wide at the truncate base.

M. pterocarpi is unique among species of *Minimelanolocus* because of its obovoid conidia with a rounded apex and a narrow base.

Acknowledgments

The authors are grateful to Dr. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30499340, 30770015, 2006FY120100).

Literature cited

Castañeda Ruíz RF, Heredia G, Reyes M, Arias RM, Decock C. 2001. A revision of the genus *Pseudospiropes* and some new taxa. Cryptogamie Mycologie 22: 3-18.

Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England 608 p.

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Taxonomic studies of *Corynespora* from Hainan, China

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Abstract — Two new species, *Corynespora litseae* on *Litsea elongata* and *Corynespora parapyrenariae* on *Parapyrenaria multisepala* are described and illustrated.

Key words — hyphomycetes, dematiaceous

Introduction

More than 200 specimens of hyphomycetes were collected from the Jianfengling tropical native forest of Hainan province, China. Among them were two previously undescribed species of *Corynespora*.

Taxonomic descriptions

Corynespora litseae Jian Ma & X.G. Zhang, **sp. nov.** FIGURE 1
MycoBank MB 511521

Coloniae atro-brunneae vel fuscae, effusae. Mycelium semper superficiale, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 1.5-4.5 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, brunnea, per usque ad 4 extensiones successivas cylindricae elongascentia, 130-310 µm longa, 4.5-7 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel leviter curvata, obclavata, pallide brunnea vel olivaceo-brunnea, laevia, 14-34-pseudoseptata, 105-235 µm longa, 10-12 µm crassa, apicem versus ad 3-5.5 µm attenuata, basi truncata 3-4.5 µm lata.

Holotype: On dead branches of *Litsea elongata* (Wall. ex Nees) Benth. & Hook. f., tropical forest of Jianfengling, Hainan Province, China. May. 2007, J. Ma, HSAUPVII$_{0MJ}$ 0246-1.

Etymology: in reference to the host, *Litsea elongata*

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* *Corresponding author*

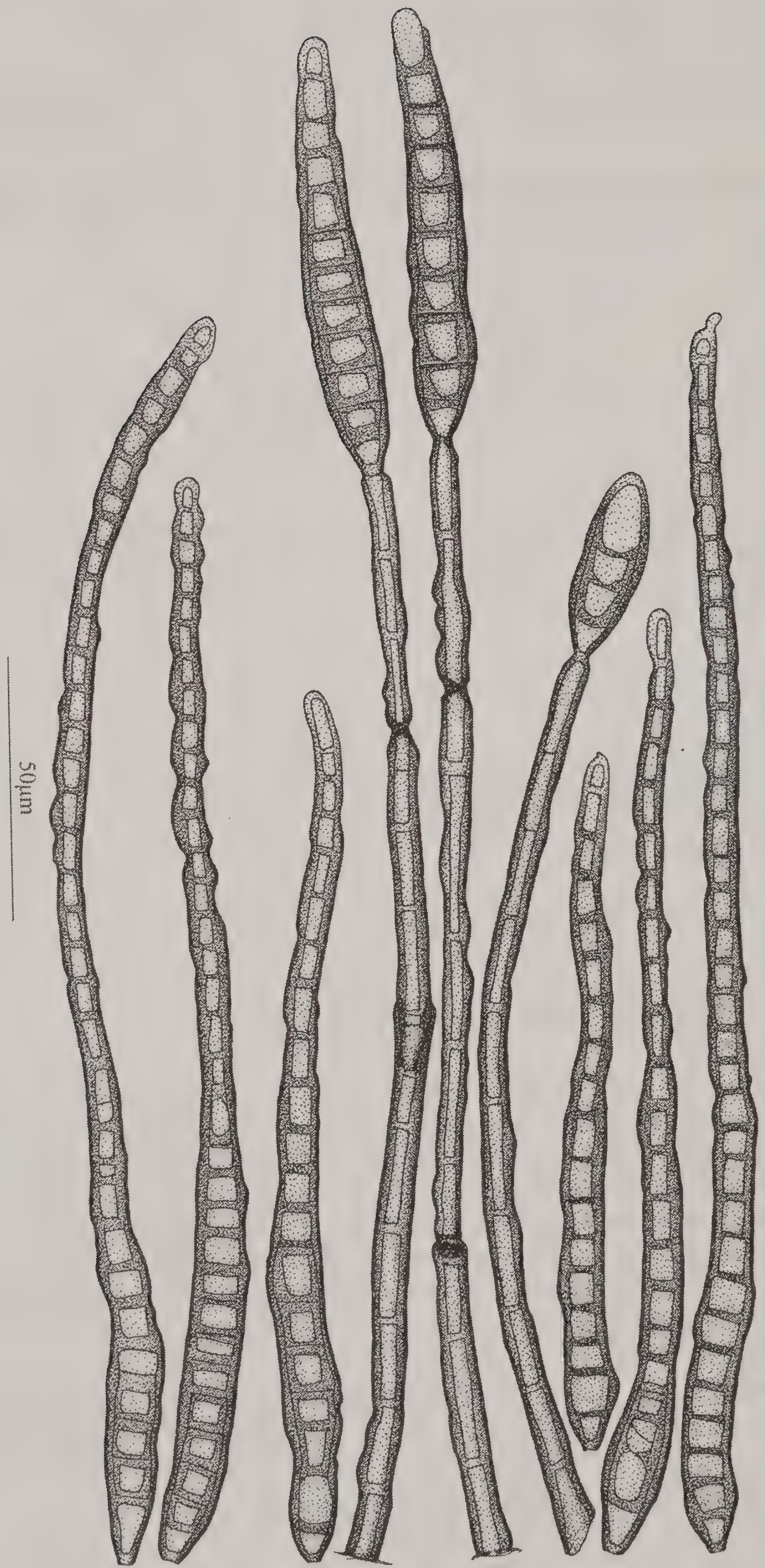

Fig. 1 Conidia and conidiophores of *Corynespora litseae*

Colonies dark brown to blackish brown, effused. Mycelium mostly superficial, composed of branched, septate, pale brown, smooth-walled hyphae, 1.5-4.5 µm thick. Stroma absent. Conidiophores arising singly or in groups, terminally and laterally on the hyphae, erect, unbranched, straight or flexuous, cylindrical, septate, smooth-walled, brown, with up to 4 successive percurrent cylindrical extensions, 130-310 µm long, 4.5-7 µm thick. Conidia formed singly through a pore at the apex of the conidiophore which, after the first conidium has fallen, sometimes extends through the apical pore and forms another conidium at the new apex. Conidia straight or slightly curved, obclavate, pale brown to olivaceous brown, smooth-walled, 14-34-pseudoseptate, 105-235 µm long, 10-12 µm thick in the broadest part, tapering to 3-5.5 µm near the apex, 3-4.5 µm wide at the truncate base.

Corynespora litseae derived from dead branches of *Litsea* in contrast to the related *C. cucurbiticola* and *C. trichoides*, which have been collected on *Coccinia grandis* (L.) Voigt and *Triumfetta rhomboidea* Jacq., respectively (Meenu et al. 1998). The conidial morphology of *C. litseae* resembles that of the two earlier described species. However, the conidia of *C. litseae* are narrower (10-12 µm) than those in *C. cucurbiticola* (6.5-20 µm diam) and *C. trichoides* (10-15 µm diam). Furthermore, the conidia in *C. liteseae* have more pseudosepta (14-34) than are found in *C. cucurbiticola* (6-22) and *C. trichoides* (3-14). In both *C. litseae* and *C. cucurbiticola*, the conidial hila are unthickened compared to the thickened conidial hila in *C. trichoides*.

Corynespora parapyrenariae Jian Ma & X.G. Zhang, **sp. nov.** FIGURE 2

MycoBank MB 511522

Coloniae fuscae, effusae. Mycelium partim superficiale sed fere immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus, 2-5 µm crassis compositum. Stromata nulla. Conidiophora singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, nonramosa, recta vel flexuosa, cylindrica, septata, laevia, brunnea vel fuscae, per usque ad 4 extensiones successivas cylindricae elongascentia, 140-390 µm longa, 6.5-10 µm crassa. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, recta vel curvata, obclavata, laevia, pallide brunnea vel brunnea, 5-9-pseudoseptata, 70-100 µm longa, 11-14 µm crassa, apicem versus ad 2.5-3.5 µm attenuata, et interdum muco subgloboso usque 8.5-12.5 µm diam. tecta, ad basi truncata 4-5 µm lata.

Holotype: On dead branches of *Parapyrenaria multisepala* (Merr. & Chun) H.T.Chang, tropical forest of Jianfengling, Hainan Province, China. May. 2007, J. Ma, HSAUPVII$_{0MJ}$ 0415. (isotype: HSAUPVII$_{0MJ}$0135).

Etymology: in reference to the host, *Parapyrenaria multisepala*

Colonies blackish brown, effused. Mycelium partly superficial, but mostly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 2-5 µm thick. Stroma absent. Conidiophores

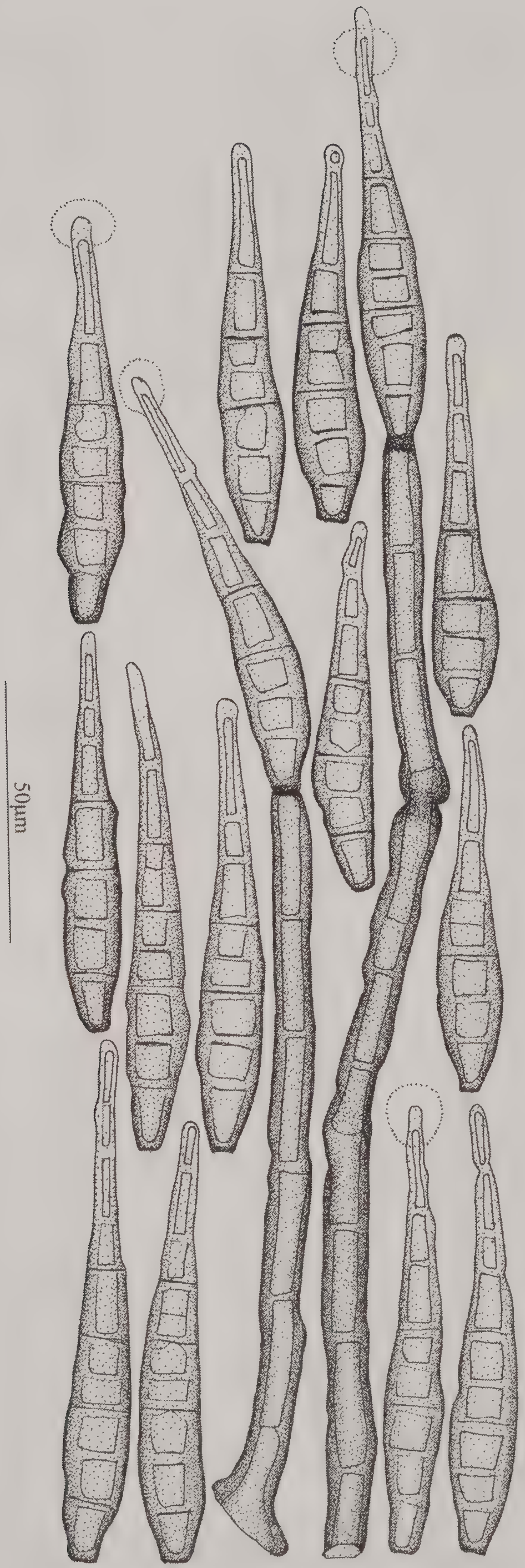

Fig. 2 Conidia and conidiophores of *Corynespora parapyrenariae*

arising singly or in fascicles, terminally and laterally on the hyphae, erect, unbranched, straight or flexuous, cylindrical, septate, smooth, brown to blackish brown, with up to 4 successive cylindrical extensions, 140-390 µm long, 6.5-10 µm thick. Conidia formed singly at the apex of the conidiophore, which then extends through the apical pore and forms another conidium at the new apex. Conidia straight or curved, obclavate, smooth-walled, pale brown to brown, 5-9-pseudoseptate, 70-100 µm long, 11-14 µm thick in the broadest part, tapering to 2.5-3.5 µm near the apex, and sometimes invested in a drop of mucilage ca 8.5-12.5 µm diam., 4-5 µm wide at the truncate base.

The conidia of *Corynespsora parapyrenariae* are similar to those of *C. gigaspora* (Ellis 1957) and *C. siwalika* (Ellis 1961). However, the conidia of *C. parapyrenariae* are smaller than those of *C. gigaspora* (100-270 × 19-28 µm) and *C. siwalika* (88-140 × 15-20 µm), and the conidia have fewer pseudosepta (5-9) than those of *C. gigaspora* (9-52) and *C. siwalika* (9-19). Moreover, the hila of the conidia are rarely thickened in *C. parapyrenariae* whereas they are thickened in *C. gigaspora* and *C. siwalika*. In addition, the conidia of this taxon occasionally have apical mucilaginous appendages that are not produced by *C. gigaspora* and *C. siwalika*.

Acknowledgments

The authors are grateful to Dr. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30499340, 30770015, 2006FY120100).

Literature cited

Ellis MB. 1957. Some species of *Corynespora*. Mycological Papers 65: 1-15.

Ellis MB. 1961. Dematiaceous hyphomycetes. III. Mycological Papers 82: 1-55.

Meenu, Kharwar RN, Bhartiya HD. 1998. Some new forms of genus *Corynespora* from Kathmandu valley of Nepal. Indian Phytopathology 51(2): 146-151.

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Two new species of *Corynespora* from Hainan, China

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Abstract—*Corynespora sed-acaciae* sp. nov. and *C. rhododendri* sp. nov are found on dead branches of *Acacia confusa* and *Rhododendron hainanense* from a tropical forest in Hainan Province of China during 2007. They are described, illustrated, and compared with similar taxa.

Key words—hyphomycetes, dematiaceous

Introduction

During collection of fungi occurring on dead branches in a tropical forest of Hainan Province, two undescribed species of *Corynespora* were discovered.

Taxonomic descriptions

Corynespora sed-acaciae K. Zhang & X.G. Zhang, **sp. nov.** FIGURE 1

MycoBank MB 511526

Coloniae griseae vel fuscae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel brunneis, laevibus, 2.5-3.5 µm crassis compositum. Stromata nulla. Conidiophora singula, mononemata, nonramosa, recta vel flexuosa, cylindrica, laevia, 8-12-septata, pallide brunnea vel brunnea, per usque ad 1-2 extensiones percurrentes successivas cylindricae, 80-140 µm longa, 5-6.5 µm crassa. Cellulae conidiogenae monotreticae, terminales, cylindricae, percurrentes, integratae. Conidia singula, primo in apice conidiophori et dein extensionis cujusque successivae oriunda, pallide brunnea vel olivaceo-brunnea, cellula basali brunnea, cellulis apicalibus 4 vel 8 pallide brunnea vel brunnea. doliiformia, usque crassa clavata, ad apicem rotundata, ad basim rotundata, recta vel curvata, laevia, 8-12-pseudoseptata, 40-70 µm longa, 11-13.5 µm crassa.

Holotype: On dead branches of *Acacia confusa* Merr., Wuzhishan, Hainan Province, China. May. 9. 2007, K. Zhang, HSAUPVII$_{0\text{-}ZK}$0322.

Etymology: in reference to the host, *Acacia confusa*

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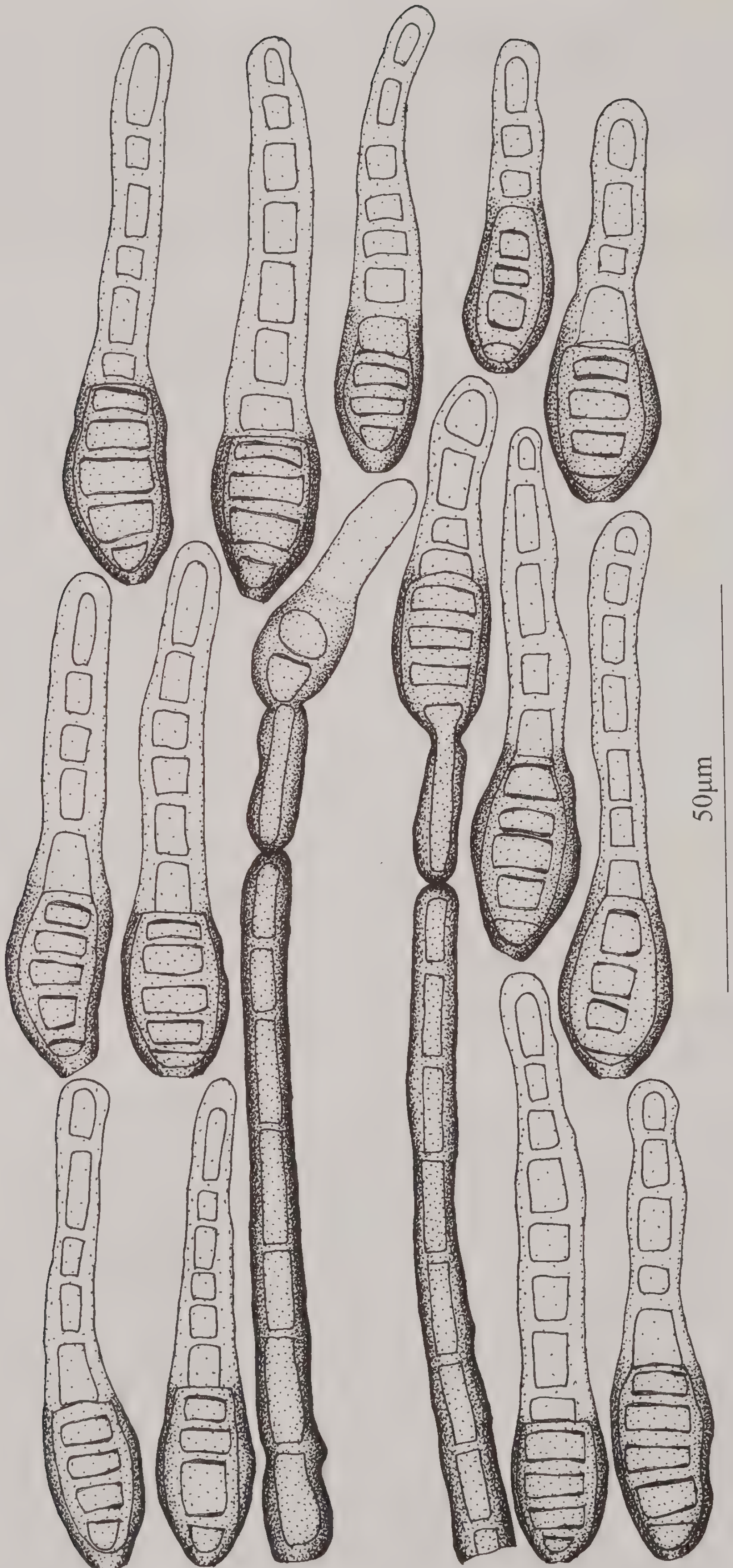

Fig. 1 Conidia and conidiophores of *Corynespora sed-acaciae*

Colonies grey to dark blackish brown, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 2.5-3.5 µm thick. Stroma absent. Conidiophores arising singly, mononematous, unbranched, straight or flexuous, cylindrical, smooth, 8-12-septate, pale brown to brown, with 1-2 successive percurrent cylindrical extensions, 80-140 × 5-6.5 µm. Conidiogenous cells monotretic, terminal, cylindrical, percurrent, integrated. Conidia formed singly at the apex of the conidiophore, which then extends through the apical pore and forms another conidium at the new apex. Conidia pale brown to olivaceous brown, basal cell dark brown, upper 4-8 cells pale brown to brown, doliiform to broadly clavate, rounded at the apex, conical at the base, straight or curved, smooth-walled, 8-12-pseudoseptate, 40-70 × 11-13.5 µm.

The conidia of *C. sed-acaciae* are similar to those of *C. cespitosa* (Ellis 1963). However, the conidia of *C. sed-acaciae* are smaller than those of *C. cespitosa* (55-85 × 18-29 µm). Moreover, the conidia of *C. sed-acaciae* are brown except for 2/3 apical cells which are subhyaline or pale brown, as opposed those of *C. cespitosa* which are all brown to dark brown. In addition, the conidia in *C. sed-acaciae* are often smooth, while those of *C. cespitosa* are often verrucose.

Corynespora rhododendri K. Zhang & X.G. Zhang, **sp. nov.** FIGURE 2

MycoBank MB 511523

Coloniae griseae vel fuscae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel brunneis, laevibus, 1.5-2.5 µm crassis compositum. Stromata nulla. Conidiophora singula, mononemata, non ramosa, recta vel flexuosa, cylindrica, laevia, 5-10-septata, pallide brunnea vel brunnea, per usque ad 1-2 extensiones percurrentes successivas cylindricae, 85-140 × 4.5-6 µm. Cellulae conidiogenae monotreticae, terminales, cylindricae, percurrentes, integratae. Conidia singula, primo in apice conidiophori et dein proliferationis cujusque successivae oriunda, pallide brunnea vel olivaceo-brunnea, fere obclavata longe attenuate, recta vel curvata, laevia, 19-36-pseudoseptata, 180-400 × 7.5-11 µm. basi trunncata 3-4 µm lata.

HOLOTYPE: On dead branches of *Rhododendron hainanense* Merr., Wuzhishan, Hainan Province, China. May. 9. 2007, K.Zhang, HSAUPVII$_{0\text{-}ZK}$0392.

ETYMOLOGY: in reference to the host, *Rhododendron hainanense.*

Colonies grey to dark blackish brown, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 1.5-2.5 µm thick. Stroma absent. Conidiophores arising singly, mononematous, unbranched, straight or flexuous, cylindrical, smooth, 5-10-septate, pale brown to brown, with 1-2 successive percurrent cylindrical extensions, 85-140 × 4.5-6 µm. Conidiogenous cells monotretic, terminal, cylindrical, percurrent, integrated. Conidia formed singly at the apex of the conidiophore, which then grows on through the apical pore and forms another conidium at the new apex. Conidia pale brown to olivaceous

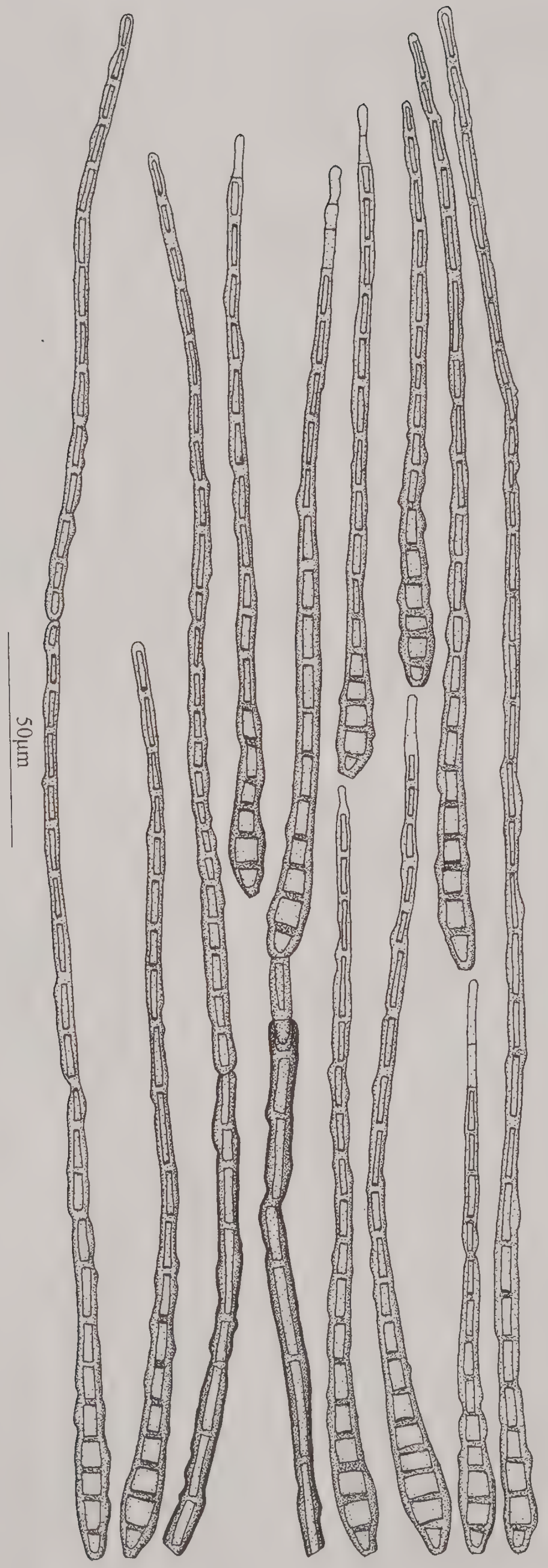

Fig. 2 Conidia and conidiophores of *Corynespora rhododendri*

brown, usually obclavate to long-rostrate, tapering to the narrow apex, straight or curved, smooth-walled, 19-36-pseudoseptate, 180-400× 7.5-11 µm, 3-4 µm wide at the truncate base.

The conidia of *Corynespora rhododendri* are similar to those of *C. micheliae* (Shang & Zhang 2007). However, the conidia of *C. rhododendri* (180-400 × 7.5-11 µm) are mostly shorter and much narrower than those of *C. micheliae* (333-360 × 15-19 µm). In addition, the width of conidial bases in *C. rhododendri* (2.5-4 µm) is narrower than that of *C. micheliae* (6-7 µm).

Acknowledgments

The authors are grateful to Dr. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30770015, 30499340, 2006FY120100).

Literature cited

Ellis MB. 1963. Dematiaceous hyphomycetes VI. Mycol. Pap. 87: 1-42.

Shang ZQ, Zhang XG. 2007. Two new *Corynespora* species from Jiangsu, China. Mycotaxon 100: 155-158.

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Taxonomic studies of *Sporidesmium* from Hainan, China

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Abstract—Two new species of *Sporidesmium*, *S. melicopes* and *S. raphiodophorae*, were collected from dead branches in Hainan, they are described, illustrated, and compared with similar taxa.

Key words—hyphomycetes, dematiaceous

Introduction

Our continuing study of microfungi occurring on dead branches in tropical forest of Hainan revealed two previously undescribed species of *Sporidesmium* Link.

Taxonomic descriptions

Sporidesmium melicopes K. Zhang & X.G. Zhang, **sp. nov.** FIGURE 1
MYCOBANK MB 511524

Coloniae effusae, fuscae, breve pilosae. Mycelium semper immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, levibus, 2-4 µm crassis compositum. Conidiophora singula, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter, flexuosa, cylindrica, pallide brunnea, 3-5-septata, 66-82 µm longa, 5-6 µm crassa. Conidia singula in apice conidiophori oriunda, recta vel leviter flexuosa, obclavata, ad apicem conica, ad basim conico-truncata, pallide brunnea, laevia, 6-12-septata, 40-64 µm longa, 8.5-12.5 µm crassa, apicem versus ad 2-3.5 µm attenuata, basi 2-3 µm lata.

HOLOTYPE: On dead branches of *Melicope triphylla* (Lam.) Merr., tropical forest of Wuzhishan, Hainan Province, China. May. 5. 2007, Kai Zhang, HSAUPVII$_{0\text{-}ZK}$0424.

ETYMOLOGY: in reference to the host, *Melicope triphylla*

Colonies effused, dark brown, shortly hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-4 µm thick. Conidiophores arising singly, terminally and

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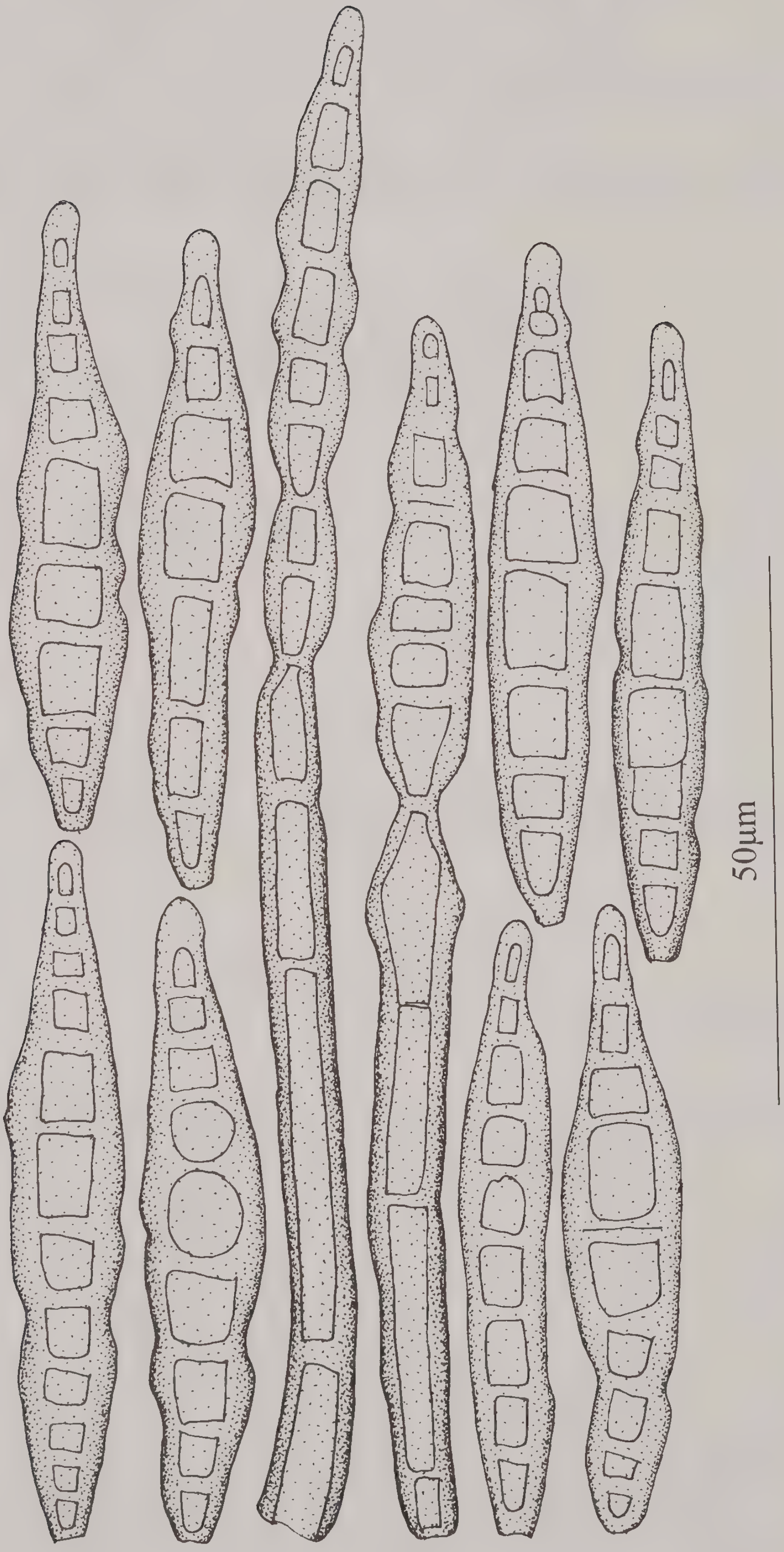

Fig. 1 Conidia and conidiophores of *Sporidesmium melicopes*

laterally on the hyphae, erect, simple, straight or slightly flexuous, cylindrical, paler brown, 3-5-septate, 66-82 µm long, 5-6 µm thick. Conidia phragmospores formed singly at the apex of the conidiophore, straight or slightly flexuous, obclavate, conical at the apex, conico-truncate at the base, paler brown, smooth-walled, 6-12-septate, 40-64 µm long, 8.5-12.5 µm thick in the widest part, tapering to 2-3.5 µm at the apex, 2-3 µm wide at the base.

In conidial morphology, *Sporidesmium melicopes* resembles *S. fraxini-paxianae* (Ma & Zhang 2007). However, the conidia of *S. melicopes* are larger than those of *S. fraxini-paxianae* (35-40 × 8-10 µm). In addition, conidia of this taxon have more septa (6-12) than those of *S. fraxini-paxianae* (4-6). The conidiophores of *S. melicopes* are also larger than those of *S. fraxini-paxianae.*

Sporidesmium rhaphidophorae K. Zhang & X.G. Zhang, **sp. nov.** FIGURE 2

MycoBank MB 511525

Coloniae effusae, fuscae. Mycelium partim superficiale sed fere immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, levibus, 1.5-3 µm crassis compositum. Conidiophora singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter flexuosa, pallide brunnea vel brunnea, 2-4-septata, 55-98 µm longa, 5.5-7.0 µm crassa. Conidia phragmosporia singula in apice conidiophori oriunda, recta vel leviter curvata, obclavata, ad basim conico-truncata, ad apicem conica vel cum appendice arguste , lavia, olivaceo-brunnea vel brunnea*, 14-17-septata, 93-200 µm longa, 12-16.5 µm crassa, apicem versus ad 2-3 µm attenuata, fastigata ad apicem in appendicem tenuem, filiformem,* primo in apice *successiva oriunda, hyalinam vel subhyalinam. basi 4-5.5 µm lata.*

Holotype: On dead branches of *Rhaphidophora decursiva* (Roxb.) Schott, tropical forest of Wuzhishan, Hainan Province, China. May. 5. 2007, Kai Zhang, HSAUPVII$_{0\text{-}}$$_{\text{ZK}}$0311-2.

Etymology: in reference to the host, *Rhaphidophora decursiva*

Colonies effused, blackish brown. Mycelium partly superficial, but mostly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 1.5-3 µm thick. Conidiophores arising singly or in fascicles terminally and laterally on the hyphae, erect, simple, straight or slightly flexuous, pale brown to brown, 2-4-septate, 55-98 µm long, 5.5-7.0 µm thick. Conidia phragmospores formed singly at the apex of the conidiophore, straight or slightly curved, obclavate, conico-truncate at the base, conical at the apex, smooth-walled, brown to olivaceous brown, 14-17-septate, 93-200 µm long, 12-16.5 µm thick in the widest part, tapering to 2-3 µm at the apex, apical appendage filiform, developing at the apex of mature conidia, hyaline to subhyaline. 4-5.5 µm wide at the base.

The conidia of *Sporidesmium rhaphidophorae* are similar to those of *S. flagelliforme* (Matsushima 1975). However, the conidia of *S. rhaphidophorae*

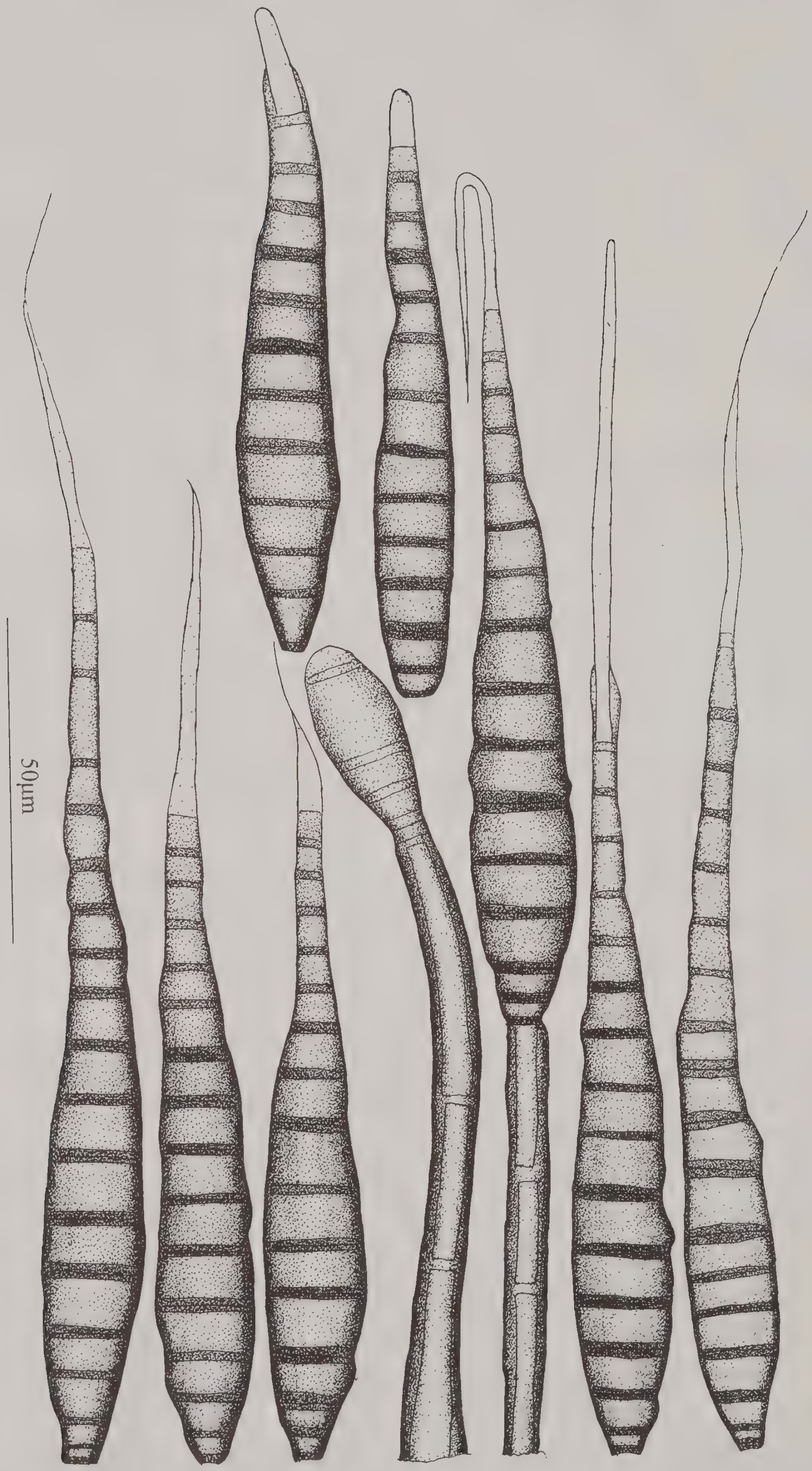

Fig. 2 Conidia and conidiophores of *Sporidesmium rhaphidophorae*

are mostly longer and much wider than those of *S. flagelliforme* (90-130 × 8-9µm). In addition, the conidia of this taxon have more septa (14-16) than those of *S. flagelliforme* (11-14).

Acknowledgments

The authors are grateful to Prof. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30770015, 30499340, 2006FY120100).

Literature cited

Ma J, Zhang XG. 2007. Two new species of *Sporidesmium* from Yunnan, China. Mycotaxon 101: 73-76.

Matsushima T. 1975. Icones Microfungorum a Matsushima Lectorum. Nippon Printing Publishing Co., Osaka 209 p. + 415 pl.

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Floromyces, a new genus of *Ustilaginomycotina*

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Abstract — A comparison of *Thecaphora anemarrhenae,* on the monocotyledonous *Anemarrhena asphodeloides* (*Agavaceae, Liliaceae* s. lat.), with *Thecaphora* species, all on eudicotyledonous host plants, revealed that it belongs to a different genus. Based on morphological characters of the sori, spore balls, spores, spore germination, host-parasite interaction and septal pore structure, as well as on DNA analyses, a new genus, *Floromyces,* is described for *T. anemarrhenae.* For both *Floromyces* and *Antherospora,* a new family, *Floromycetaceae* is proposed within the *Urocystales.*

Key words — *Floromyces anemarrhenae, Floromycetaceae,* new combination, smut fungi, taxonomy

Introduction

The genus *Thecaphora* Fingerh., within the *Glomosporiaceae* Cif., has 58 known species (Vánky et al. 2008, in press). All but two species parasitize eudicotyledonous plants in 16 families. Two *Thecaphora* species infect monocotyledonous plants (*Liliidae*) in the *Liliaceae* s. lat. One of these, *T. bulbinellae* P.H.B. Talbot (type on *Bulbinella setosa* (Willd.) T. Durand & Schinz, *Asphodelaceae, Liliaceae* s. lat., South Africa), has sterile cells around the spores in the balls as seen by examining bleached spore balls. Its ultrastructure is also typical for the *Urocystales.* Consequently, it will be transferred into the genus *Urocystis,* as *U. bulbinellae* (P.H.B. Talbot) Vánky et al. (Vánky 2008, in prep.). We also studied the morphology of the sori, spore balls, spores, ultrastructure of host-parasite interaction and septal pore, and spore germination of *T. anemarrhenae* (type on *Anemarrhena asphodeloides, Agavaceae,* China), which indicated that it does not belong to the genus *Thecaphora*. Molecular biological analysis confirmed the separate position of *T. anemarrhenae* and motivates our description of a new genus (*Floromyces*) for it (comp. also Vánky 2002). A new family, *Floromycetaceae,* within the *Urocystales* is also proposed to accommodate this new genus and the newly described *Antherospora* R. Bauer et al. (Bauer et al. 2008, in press).

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Materials and methods

Specimens examined: *Thecaphora anemarrhenae* on *Anemarrhena asphodeloides*, isotype, China (see the description below); China, Liaoning Prov., 31.V.1976, X.X. Gu, HMAS 36750, HUV 12008; China, Shanxi Prov., Jianxian County, VIII.1985, X.L. Bai, comm. B. Liu, HUV 12088; China, Inner Mongolia, Chifeng city (Ulanhad), Hongshan Distr., Hongshan, 15.VII.2007, T.Z. Liu, HUV 21482. DNA sequences were obtained from the isotype of *T. anemarrhenae*, HUV 21482.

Morphological examination

Sorus structure, spore ball development, mature spore balls and spore characteristics were studied using dried herbarium specimens. For light microscopy (LM), spore balls and spores were dispersed in a droplet of lactophenol on a microscope slide, covered with a cover slip, gently heated to boiling point to rehydrate the spores and to eliminate air bubbles, and examined at 1000× magnification. For examination of spore ball development, young sori were boiled in a mixture of lactophenol with cotton blue and distilled water, on a microscope slide. Under a stereo microscope, the sori were dissected. Pieces of host tissues from the basal part of the sori, and very young spore balls were transferred into a droplet of lactophenol with cotton blue, covered with a cover slip, and gently pressure applied until the host tissue became flat. Air bubbles were eliminated by gently heating to boiling point. For scanning electron microscopy (SEM), dry spore balls were placed on double-sided adhesive tape, mounted on a specimen stub, sputter-coated with gold-palladium, c. 20 nm, and examined at 10 kV.

For spore germination, freshly collected spore balls of *Thecaphora anemarrhenae* (HUV 21482) were dusted on a microscope slide, which was placed in a Petri dish with wet blotting paper, creating humid conditions. When the spores germinated, a droplet of lactophenol with cotton-blue was added, covered by a cover slip and examined with LM at 1000× magnification. A suspension of spore balls in sterile water was also placed on water agar (WA) and malt-yeast-peptone-agar (MYP, according to Bandoni 1972), in Petri dishes. When the spores germinated, a c. 1 × 1.5 cm square was cut out, placed on a microscope slide, stained and examined as described above.

For ultrastructural studies, young sori from herbarium specimen were rehydrated by gently boiling in distilled water. Pieces from their basal part were fixed with 2 % glutaraldehyde in 0.1 M sodium cacodylate buffer (pH 7.2) at room temperature. Following six transfers in 0.1 M sodium cacodylate buffer, samples were postfixed in 1 % osmium tetraoxide in the same buffer for 1 h in the dark, washed in distilled water, and stained in 1 % aqueous uranyl acetate for 1 h in the dark. After five washes in distilled water, samples were dehydrated in acetone, using 10 min changes at 25 %, 50 %, 70 %, 95 %, and 3 times in 100 % acetone. Samples were embedded in Spurr's plastic and sectioned with a diamond knife. Serial sections were mounted on formvar-coated, single-slot copper grids, stained with lead citrate at room temperature for 5 min, and washed with distilled water. The specimens were studied with a Zeiss EM 109 transmission electron microscope at 80 kV.

For semi-thin sections, similarly embedded material was sectioned, transferred to a microscope slide, stained with new fuchsin and crystal violet, mounted in Entellan under a cover slip, and studied by LM at various magnifications.

DNA extraction, PCR, and sequencing

Genomic DNA was isolated directly from the herbarium specimen of the isotype (HUV 21482). For methods of isolation and crushing of fungal material, DNA extraction, amplification, purification of PCR products, sequencing, and processing of the raw data see Lutz et al. (2004). The 5′-end of the nuclear large subunit ribosomal DNA (LSU rDNA, 635 bp) was amplified using the primer pair LR0R and NL4 (O′Donnell 1992, 1993, White et al. 1990). Primers were used for both PCR and cycle sequencing. For amplification we adjusted the annealing temperature to 45 °C. The DNA sequence prepared in the course of this study was deposited in GenBank (accession number EU221284).

Phylogenetic analyses

To obtain a hypothesis on the phylogenetic placement of *Thecaphora anemarrhenae* we analysed its LSU rDNA sequence within a dataset containing sequences of representatives of the *Urocystales*, the *Ustilaginales* as well as three species of the *Exobasidiomycetidae* (GenBank accession numbers are given in Fig. 11).

To align sequences, we used MAFFT 5.861 (Katoh et al. 2002, 2005) with the L-INS-i option. Both manipulation of the alignment (length: 556 bp, 268 variable sites) by hand and manual exclusion of any positions was avoided as recommended by Giribet & Wheeler (1999) and Gatesby et al. (1993), respectively.

To estimate phylogenetic relationships, we applied both neighbour-joining analysis and a Bayesian approach. For neighbour-joining analysis the data were first analysed with Modeltest 3.7 (Posada & Crandall 1998) to find the most appropriate model of DNA substitution. The hierarchical likelihood ratio test proposed the TrN+G DNA substitution model. Bootstrap values were calculated for 1000 replicates. For Bayesian analysis we used a Bayesian approach of phylogenetic inference using a Markov chain Monte Carlo (MCMC) technique as implemented in the computer program MrBayes 3.1.2 (Huelsenbeck & Ronquist 2001, Ronquist & Huelsenbeck 2003). Four incrementally heated simultaneous Markov chains were run over 2 000 000 generations using the general time reversible model of DNA substitution with gamma distributed substitution rates and estimation of invariant sites, random starting trees and default starting parameters of the DNA substitution model as recommended by Huelsenbeck & Rannala (2004). Trees were sampled every 100th generation resulting in an overall sampling of 20 001. From these, the first 2 001 trees were discarded (burnin = 2 001). The trees sampled after the process had reached stationarity (18 000 trees) were used to compute a 50% majority rule consensus tree to obtain estimates for the a posteriori probabilities of groups of species. This Bayesian approach of phylogenetic analysis was repeated five times to test the independence of the results from topological priors (Huelsenbeck et al. 2002). Trees were rooted with the species belonging to the *Exobasidiomycetidae*, *Entyloma microsporum* (Unger) J. Schröt., *Exobasidium pachysporum* Nannf., and *Phragmotaenium indicum* (Vánky et al.) R. Bauer et al.

Results

Morphological results

In squashed host tissues from the basal part of a young sorus of *Thecaphora anemarrhenae*, stained with cotton blue in lactophenol, septate, ramified, 2-3 µm wide hyphae were present with haustoria that appeared as short, lateral, knob-like or stalked branches with swollen, bent, hook-like or spirally coiled tips. In the same material spore ball development was also observed (see description below).

Spore germination started within a few hours of exposure to moisture. After 6-12 hours fully developed basidia with basidiospores and also long, septate filaments were present both on water, on WA and on MYP. Germination was more abundant on MYP.

Ultrastructural results

The fungus forms intracellular, aseptate haustoria with an electron-opaque matrix coating the haustorial cell wall (Fig. 8). These haustoria have a morphology distinct from the intercellular hyphae. The septa (Fig. 9) in soral hyphae in *Thecaphora anemarrhenae* have simple pores with rounded pore lips. The caps and also bands in the pores are of poor contrast.

Phylogenetic results

The different runs of Bayesian phylogenetic analyses that were performed and the neighbour-joining analysis yielded consistent topologies. We present the consensus tree of one run of Bayesian phylogenetic analyses to illustrate the results (Fig. 11). Estimates for a posteriori probabilities are indicated on branches before slashes. Bootstrap values from the neighbour-joining analysis are indicated after slashes.

In all analyses *Thecaphora anemarrhenae* clustered within the *Urocystales* as sister taxon to the three *Antherospora* species sampled. *Antherospora* and *Thecaphora anemarrhenae* were revealed as sister group to the remaining members of the *Urocystaceae* sampled. *Mycosyrinx cissi* (DC.) Beck was revealed in a basal position to the mentioned groups.

Taxonomy

Based on our examination of *Thecaphora anemarrhenae*, we propose a new genus in a new family as follows:

Floromyces Vánky, M. Lutz & R. Bauer, **gen. nov.**

MycoBank 511264

> *Sori in floribus* Agavaceae *(*Liliaceae *s. lat.) massam pulveream, atrobrunneam glomerulorum sporarum formantes. Peridium, columella et cellulae steriles absentes. Infectio systemica. Glomeruli sporarum permanentes, e sporis tantum compositi. Sporae pigmentosae (olivaceo- vel rufobrunneae, sine violaceo, aurantiaco vel ferrugineo colore). Germinatio sporarum basidiis septatis, nonseptatis et etiam hyphis ramiferis nonseptatis. Basidiosporae plerumque septatae, in sterigmatibus productae, sporidiis secundariis vel hyphis germinantes. Interactio parasitica per haustoria. Porus septalis simplex. Typus generis:* F. anemarrhenae, *in opera ipso designatus.*
>
> Etymology: *Floro-* derived from the Latin *flos, floris* meaning flower, referring to the place of the sori, and *-myces* from the Greek word for fungus.

Sori in host plants in *Agavaceae* (*Liliaceae* s. lat.) forming a dark coloured (blackish-brown), powdery mass of spore balls in the flowers. Peridium, columella and sterile cells lacking. Infection systemic. Spore balls permanent, composed of spores only. Spores pigmented (olivaceous- or reddish-brown, without violet, orange or rusty colour). Spore germination results in both septate and non-septate basidia and also in ramifying, non-septate hyphae. Basidiospores usually septate, produced on sterigmata, germinating by secondary sporidia or by hyphae. Host-parasite interaction by haustoria. Septal pore simple. Type of the genus: *F. anemarrhenae.*

Floromyces anemarrhenae (C.H. Chow & Chi C. Chang) Vánky, M. Lutz & R.Bauer, **comb. nov.**

MycoBank 511265

> Basionym: *Thecaphora anemarrhenae* C.H. Chow & Chi C. Chang, Acta Microbiol. Sinica 14:161, 1974. — Type on *Anemarrhena asphodeloides*, China, Liaoning Prov., Tungling, Shenyang, "in Instituto Investigationis Pharmacopaeiae Provinciae Liaoning", 20.VI.1963, C.H. Chow & Chi C. Chang, HMAS 35509; isotype HUV 12007!

Sori (Fig. 1) in all flowers of an inflorescence, in the inner floral organs including gynoeceum (Figs 2, 3), enclosed by hypertrophied perianths, filled with a blackish-brown, powdery mass of spore balls. Peridium, columella and sterile cells lacking. Infected inflorescence shortened. Spore balls (Figs 5, 6, 7) globose, subglobose, ellipsoidal to slightly irregular, 16-45 × 20-60 μm, olivaceous-brown, composed of 6-20 (or more?), firmly united spores which rupture rather than separate by hard pressure. Spores (Figs 5, 6, 7) broadly subcuneiform, in surface view rounded subpolygonally irregular, rarely circular or elliptic, 9-13 × 9-16 μm, radially 8-15 μm long, olivaceous-brown; wall of the flattened, contact sides 1-2 μm thick, smooth, that of the convex, free surface 1.5-3 μm thick, finely, densely, uniformly verruculose which just affects the spore profile. The spore balls differentiate within a hyaline mass of sporogenous hyphae (Figs 4, 5). In these, at first small, scattered groups of mycelia with short, filamentous protoplasm appear, without a concentric arrangement. These

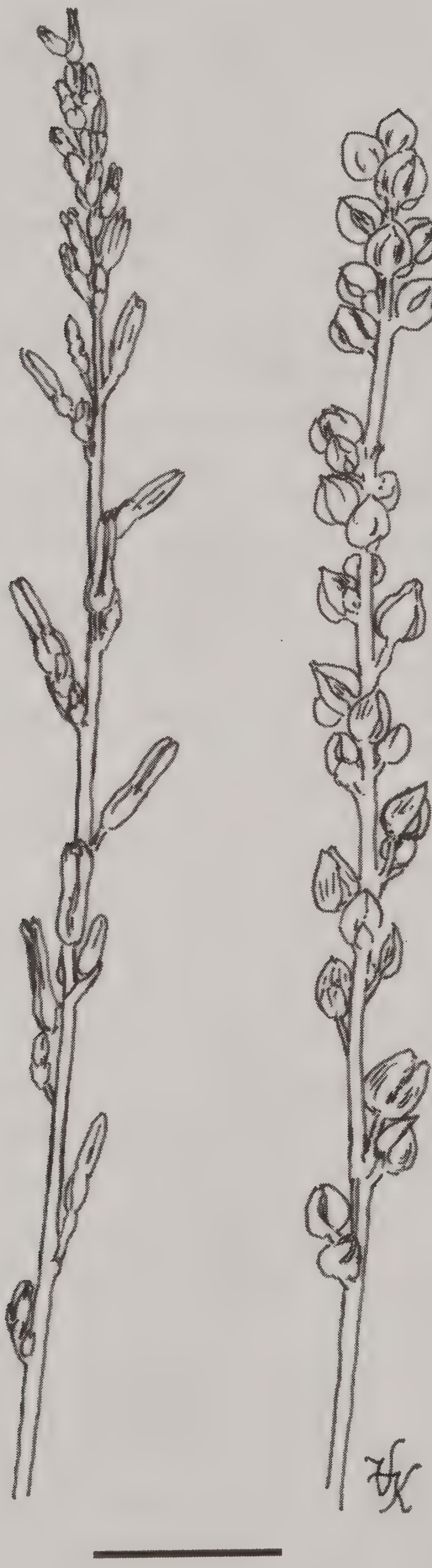
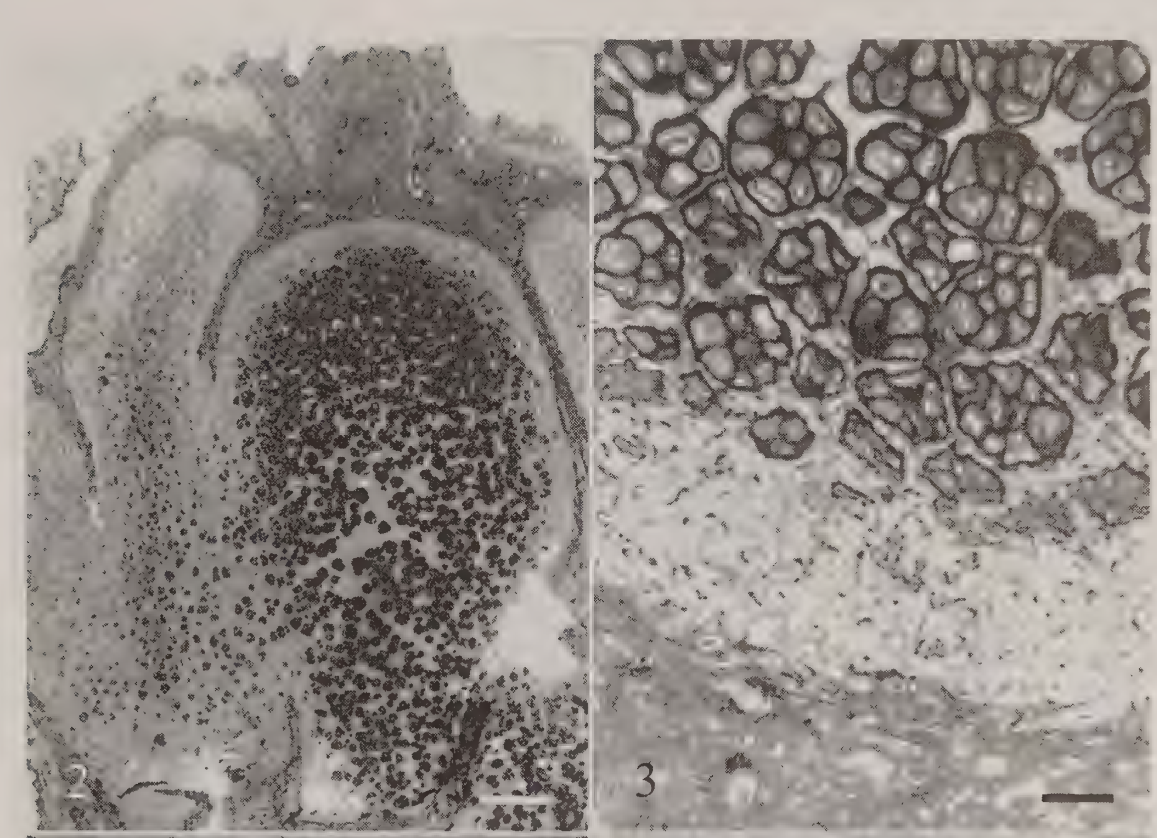
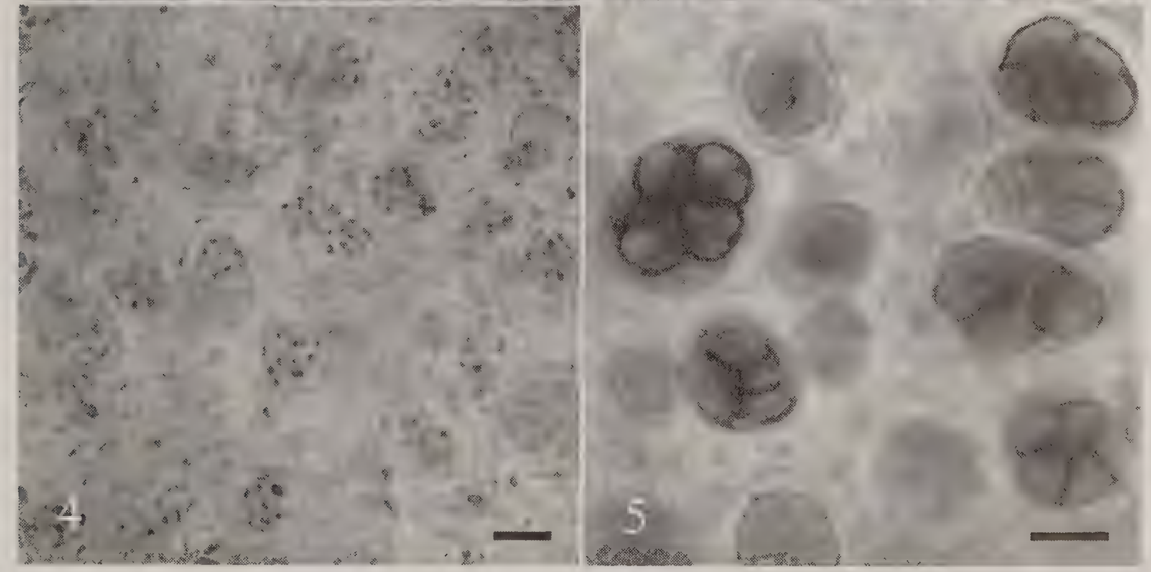


Fig. 1. Sori of *Floromyces anemarrhenae* in all flowers of an inflorescence of *Anemarrhena asphodeloides* (type). Habit, and to the left a healthy inflorescence. Bar = 1 cm.

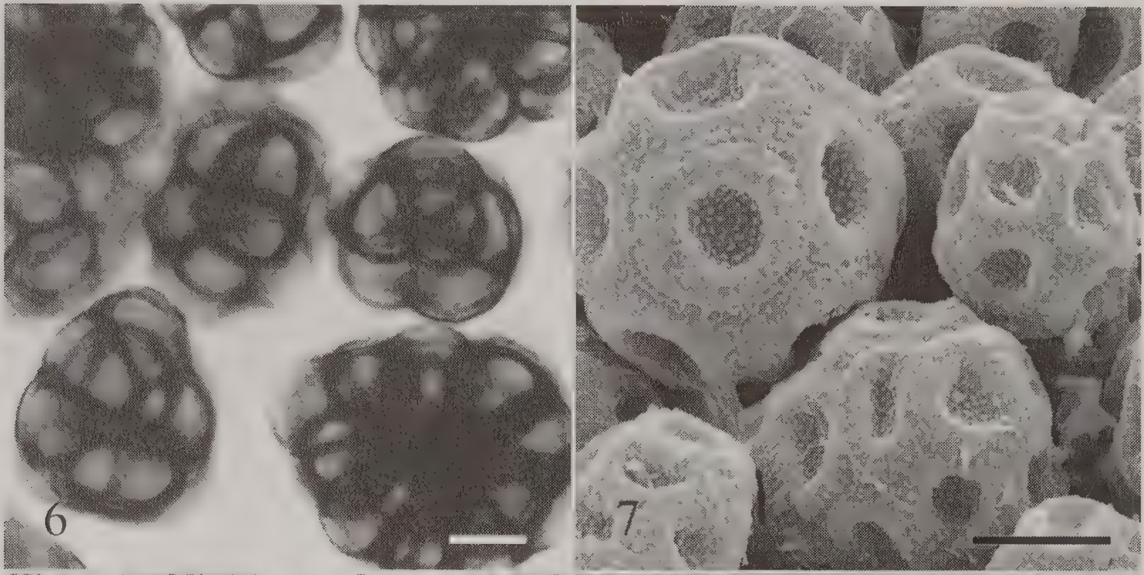


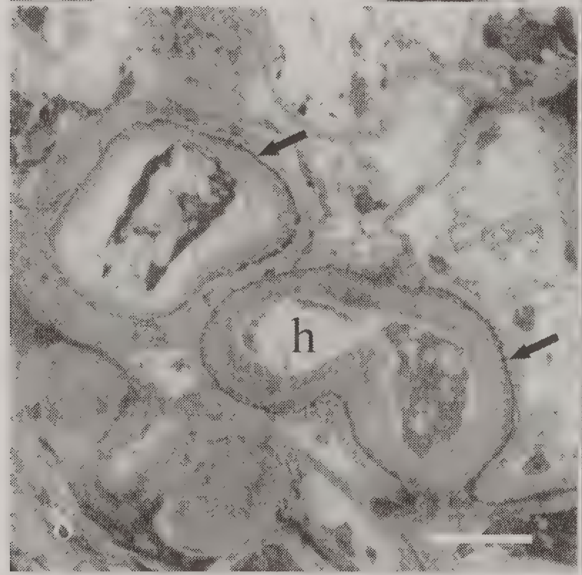


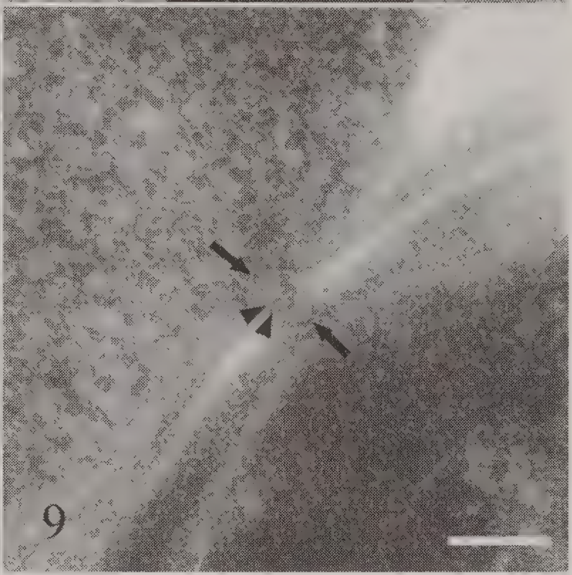
Figs 2, 3. Semi-thin, stained, longitudinal sections of a young sorus of *Floromyces anemarrhenae* (type), showing developing spore balls in the host tissue of inner floral organs, including gynoeceum, in LM. Bar for Fig. 2 = 100 μm, for Fig. 3 = 10 μm.

Figs 4, 5. Spore ball development of *Floromyces anemarrhenae* (HUV 21482), showing various developmental stages in a squashed, young sorus, in lactophenol with cotton blue, in LM. Bars = 10 μm.

gradually become swollen, increase in size, whereas the surrounding, hyaline, fungal mass is gradually consumed and disappears. Finally, mature spore balls fill the centre of the sori whereas spore balls still develop on the surface of host tissues (Fig 3). Spore germination (Fig. 10) results in long-ellipsoidal,







Figs 6, 7. Spore balls and spores of *Floromyces anemarrhenae* on *Anemarrhena asphodeloides* (type), in LM and in SEM. Bars = 10 μm.

Fig. 8. Section through a haustorium (h). Note the electron-opaque matrix coating the haustorial wall (arrows). Bar = 2 μm.

Fig. 9. Simple pore with two outer caps (arrows) and two inner plates (arrowheads). Bar = 0.1 μm.

broadly fusiform or cylindrical, (2-)3-8(-14)-celled phragmobasidia, measuring 2.5-4 × 8-26 μm, usually on a narrow pedicel. Basidiospores are produced on well-developed sterigmata both laterally and apically on the basidia. Spore germination sometimes results in short holobasidia that produce a few, long-ellipsoidal basidiospores on apical sterigmata. Spores may germinate also by long, aseptate or sparsely septate hyphae. Mature basidiospores (1-)2(-3)-celled, long ellipsoidal or broadly fusiform, measuring 2.5-4 × 8-26 μm, giving rise to secondary sporidia or to hyphae. No conjugation of basidial cells or basidiospores was observed. In one-day old culture the long, 1.5-2.5 μm wide hyphae dominate the picture. HOST-PARASITE INTERACTION by haustoria (Fig. 8). SEPTAL PORE simple (Fig. 9).

On *Agavaceae* (*Liliaceae* s. lat.): *Anemarrhena asphodeloides* Bunge; C and E Asia. Known from several localities in SE China, including Mongolia.

Discussion

Both *Thecaphora* and *Floromyces* are plant parasitic basidiomycetous microfungi. Common characters are the presence of pigmented spore balls composed of spores only, produced in sori that lack a peridium and columella, and the absence of sterile cells between or in the spore balls. However, the two genera differ in several respects. Whereas species of *Thecaphora* parasitize eudicotyledonous plants, the type of *Floromyces* infects a monocotyledonous plant. The colour of the spore mass in *Thecaphora* species varies from pale yellowish-brown to dark reddish-brown, while *Floromyces* has a dark blackish-brown spore mass. Spore ball development, spore ball and spore morphology in the two genera are different. Spore balls in *Thecaphora* species are formed from groups of coiled sporogenous hyphae (for *T. affinis* see Vánky 1994:225, 230). Mature spore balls of *Thecaphora* species are usually loose, composed of wedge-shaped spores that separate by pressure (rarely the spore balls are permanent or the spores are solitary and do not form balls). The free wall of spores of *Thecaphora* species is thickened, usually prominently ornamented.

Spore germination in *Thecaphora* species is not uniform (comp. Vánky et al. 2008, in press), but it is different from spore germination in *Floromyces anemarrhenae*. (For spore germination of *T. seminis-convolvuli* see Nagler 1986:56; for that of *T. saponariae* see Ingold 1987:473). The unusual spore germination in *Floromyces anemarrhenae* can in some way be compared with that of *Urocystis thaxteri* Vánky, on *Hypoxis acuminata* Baker (*Hypoxidaceae*, *Amaryllidaceae* s. lat.), in which both short holobasidia, with 4-8 ovoid, apical basidiospores are produced, which conjugate in pairs, each pair producing a hypha, or two different kinds of unbranched hyphae are produced, narrow (1.5-2 µm) or wide (3-4 µm) ones. On the top of these hyphae long, thin, respectively short, wide, 3-celled, spore-like bodies are produced (which can interpreted as a 3-celled basidium), of which the two smaller cells at the two ends conjugate by a long conjugation tube (Ingold 1999, as *U. hypoxis*). The unusually rapid spore germination in *F. anemarrhenae* is certainly an adaptation to the arid climate, with long, dry periods and occasional rainfalls. Under conditions of high humidity and optimal temperature, the spores germinate rapidly and infect host plants producing systemic infection. In *Thecaphora* (classified into *Glomosporiaceae* Cif. of the order *Ustilaginales* G.P. Clinton) the host-parasite interaction is by intracellular hyphae (for the definition of intracellular hyphae and haustoria see Bauer et al. 1997), and mature septa are poreless.

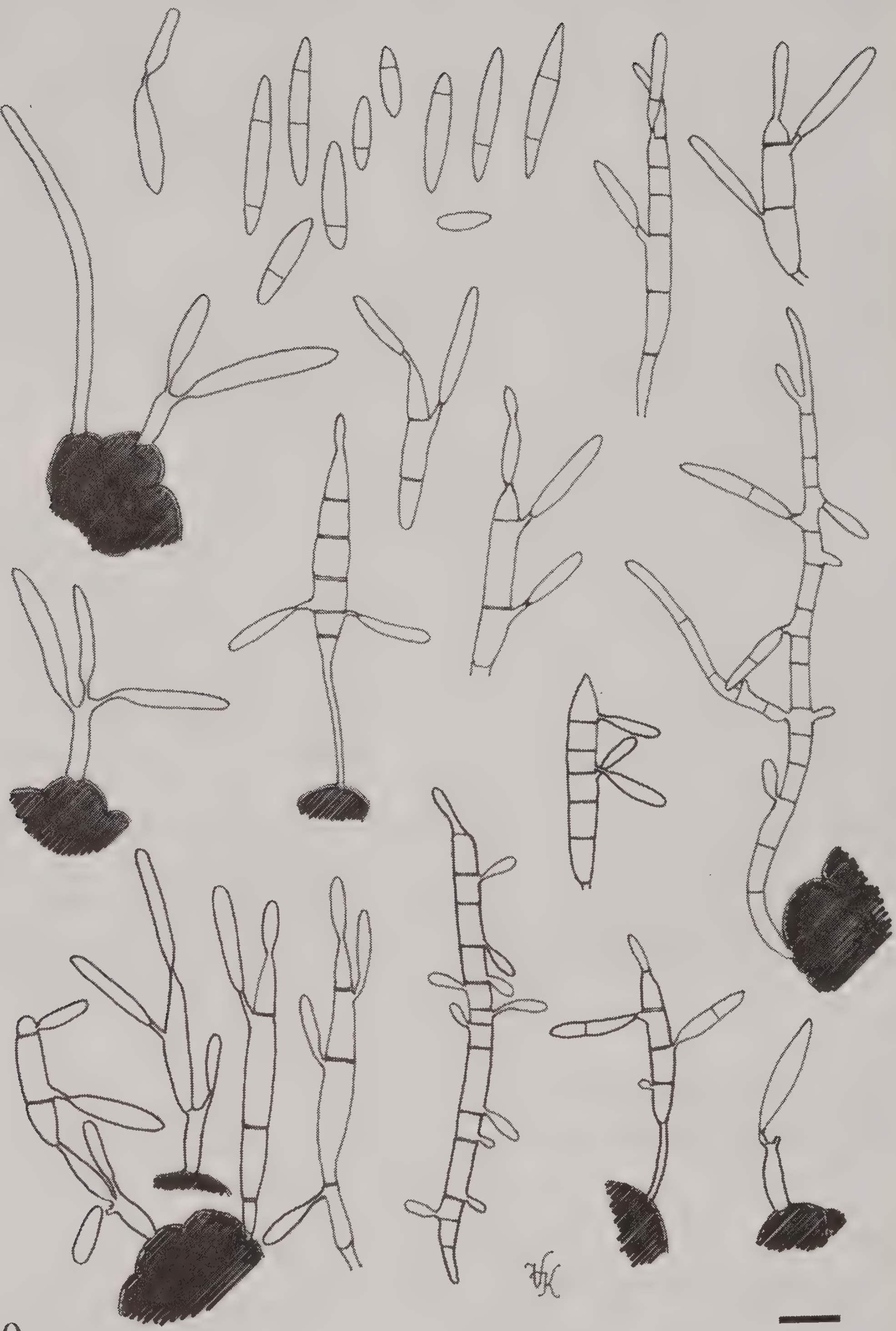


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Fig. 10. Spore germination of *Floromyces anemarrhenae* (HUV 21482). Illustrated are some short holobasidia, producing apically a few, long-ellipsoidal basidiospores on sterigmata. Several, few- to many-celled phragmobasidia, developed on pedicels, are producing laterally and apically broadly fusiform basidiospores. One spore is germinating with aseptate hypha. On the top, mature, (1-)2(-3)-celled basidiospores, one of them giving rise to a secondary sporidium on a sterigma. Bar = 10 µm.

Table 1. The main differences between *Floromyces* and *Antherospora.*

GENUS	*FLOROMYCES*	*ANTHEROSPORA*
HOST PLANT FAMILY	*Agavaceae*	*Hyacinthaceae*
SORI	Destroying the inner floral organs	Mainly in anthers, also on the surface of inner floral organs
SPORE BALLS	Present, persistent	Absent
SPORES	Subangular, broadly wedge-shaped	Globoid, ellipsoidal, slightly irregular, not subangular
SPORE GERMINATION results in	2-14-celled, pedicelled phragmobasidia, or in short holobasidia, or in hyphae	4-celled basidia (in 3 + 1 arrangement)
BASIDIOSPORES	2-3-celled, on well-developed sterigma	1-celled, sessile or on minute sterigma

In *Floromyces* the host-parasite interaction is by haustoria, coated by an electron-opaque material (Fig. 8), and the septa have simple pores with two outer caps and two inner plates (Fig. 9). Within the subphyl. *Ustilaginomycotina* (Bauer et al. 2006), the formation of haustoria with an electron-opaque matrix and simple pores characterise the *Doassansiopsaceae* and *Urocystaceae* of the *Urocystales* (Bauer et al. 1997, 2001; Begerow et al. 1998). *Floromyces anemarrhenae* shares these characteristics with members of these two families. These similarities indicate that *F. anemarrhenae* belongs to the monophyletic clade formed by the representatives of the two families clade (e.g. Bauer et al. 2001, Begerow et al. 1998).

Molecular analyses agree well with the recognized differences between *F. anemarrhenae* and the remaining *Thecaphora* species. *Floromyces anemarrhenae* clusters as sister taxon to *Antherospora* (comp. Fig. 11).

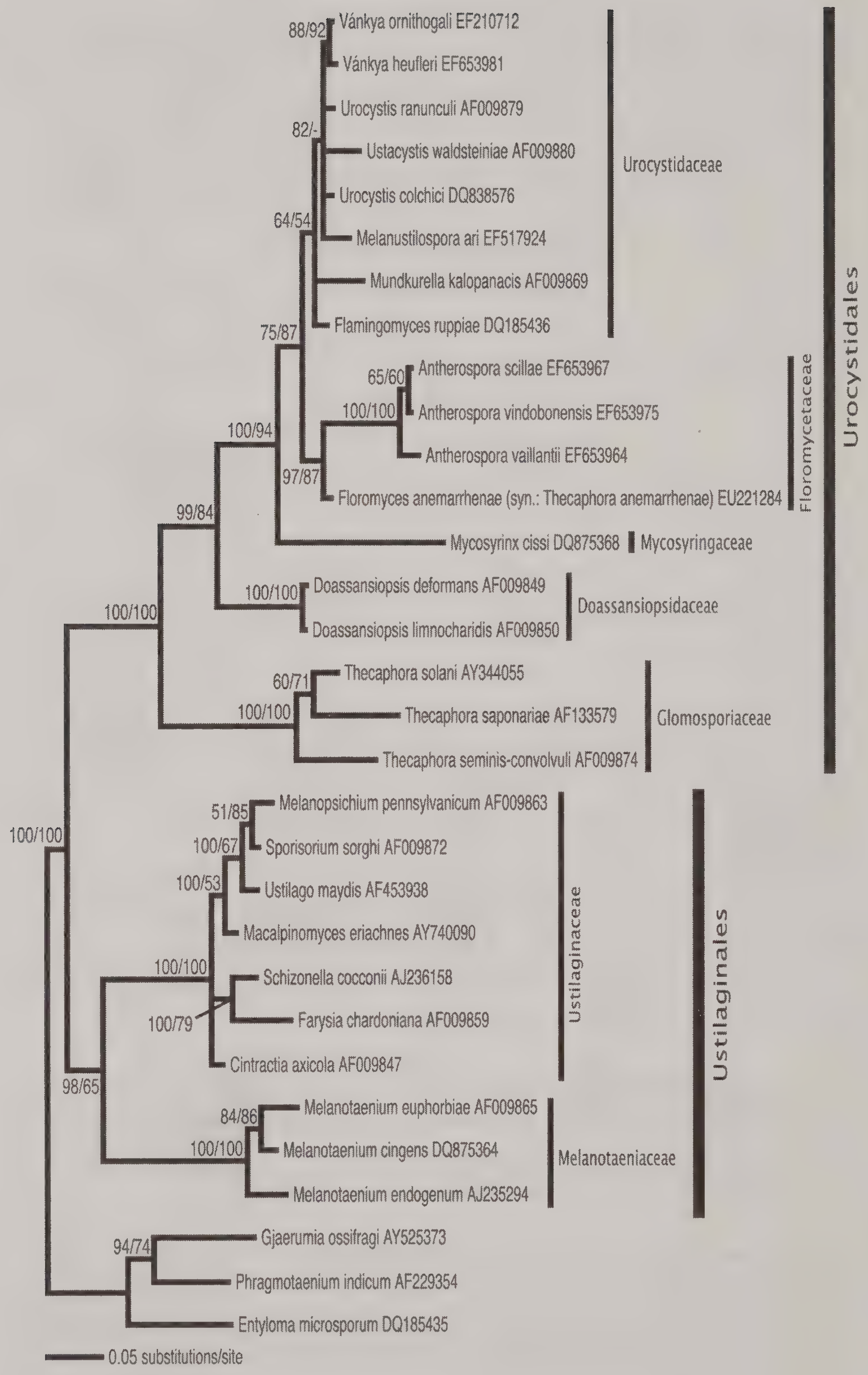
In addition to the molecular differences, *Floromyces* differs from *Antherospora* in several aspects, as shown in the Table 1.

Proposal and description of the new family

Floromyces and *Antherospora* form a well-supported monophylum within the *Urocystales* that represent the sister group of the *Urocystaceae*. Therefore, a new family for *Floromyces* and *Antherospora* is necessary.

Floromycetaceae M. Lutz, R. Bauer & Vánky, **fam. nov.**
MYCOBANK 511311

Fungi Urocystalium *sensu Bauer et al. (1997) in floribus specierum* Monocotyledonearum *sporulantes. Sporae pigmentosae, singulares vel agglomeratae, sine cellulis sterilibus. Typus familiae:* Floromyces.


88/92
Vánkya ornithogali EF210712
Vánkya heufleri EF653981
Urocystis ranunculi AF009879
82/-
Ustacystis waldsteiniae AF009880
Urocystis colchici DQ838576
64/54
Melanustilospora ari EF517924
Mundkurella kalopanacis AF009869
Flamingomyces ruppiae DQ185436
Urocystidaceae
75/87
65/60
Antherospora scillae EF653967
100/100
Antherospora vindobonensis EF653975
100/94
Antherospora vaillantii EF653964
97/87
Floromyces anemarrhenae (syn.: Thecaphora anemarrhenae) EU221284
Floromycetaceae
99/84
Mycosyrinx cissi DQ875368
Mycosyringaceae
100/100
Doassansiopsis deformans AF009849
100/100
Doassansiopsis limnocharidis AF009850
Doassansiopsidaceae
60/71
Thecaphora solani AY344055
100/100
Thecaphora saponariae AF133579
Thecaphora seminis-convolvuli AF009874
Glomosporiaceae
Urocystidales
51/85
Melanopsichium pennsylvanicum AF009863
100/100
100/67
Sporisorium sorghi AF009872
100/53
Ustilago maydis AF453938
Macalpinomyces eriachnes AY740090
100/100
Schizonella cocconii AJ236158
100/79
Farysia chardoniana AF009859
Cintractia axicola AF009847
Ustilaginaceae
98/65
84/86
Melanotaenium euphorbiae AF009865
100/100
Melanotaenium cingens DQ875364
Melanotaenium endogenum AJ235294
Melanotaeniaceae
Ustilaginales
94/74
Gjaerumia ossifragi AY525373
Phragmotaenium indicum AF229354
Entyloma microsporum DQ185435
0.05 substitutions/site

Members of the *Urocystales* sensu Bauer et al. (1997) sporulating in the flowers of monocots. Spores pigmented, single or in balls, sterile cells lacking.

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Literature cited

Bandoni RJ. 1972. Terrestrial occurrence of some aquatic hyphomycetes. Can. J. Bot. 50: 2283-2288.

Bauer R, Begerow D, Nagler A, Oberwinkler F. 2001. The *Georgefischeriales*: a phylogenetic hypothesis. Mycol. Res. 105: 416-424.

Bauer R, Lutz M, Oberwinkler F. 2006. *Gjaerumia*, a new genus in the *Georgefischeriales* (*Ustilaginomycetes*). Mycol. Res. 109: 1250-1258.

Bauer R, Oberwinkler F, Vánky K. 1997. Ultrastructural markers and systematics in smut fungi and allied taxa. Canad. J. Bot. 75: 1273-1314.

Bauer R, Lutz M, Begerow D, Piątek M, Vánky K, Bacigálová M, Oberwinkler F. 2008. Anther smut fungi on monocots. Mycol. Res. (in press).

Begerow D, Bauer R, Oberwinkler F. 1998 ('1997'). Phylogenetic studies on nuclear large subunit ribosomal DNA sequences of smut fungi and related taxa. Canad. J. Bot. 75: 2045-2056.

Chow CH, Chang CC. 1974. A new smut fungus on *Anemarrhena asphodeloides* Bge. – Acta Microbiol. Sin. 14:161-163.

Gatesy J, DeSalle R, Wheeler W. 1993. Alignment-ambiguous nucleotide sites and the exclusion of systematic data. Molecular Phylogenetics and Evolution 2: 152-157.

Fig. 11. Bayesian inference of phylogenetic relationships within the sampled *Ustilaginomycetes*: Markov chain Monte Carlo analysis of an alignment of LSU rDNA sequences using the GTR+I+G model of DNA substitution with gamma distributed substitution rates and estimation of invariant sites, random starting trees and default starting parameters of the DNA substitution model. A 50% Majority-rule consensus tree computed from 18 000 trees that were sampled after the process had reached stationarity is shown. The topology was rooted with *Entyloma microsporum, Exobasidium pachysporum,* and *Phragmotaenium indicum.* Numbers on branches before slashes are estimates for a posteriori probabilities, numbers on branches after slashes are percentage bootstrap values of 1000 replicates. Branch lengths were averaged over the sampled trees. They are scaled in terms of expected numbers of nucleotide substitutions per site.

Giribet G, Wheeler WC. 1999. On gaps. Molecular Phylogenetics and Evolution 13: 132-143.

Huelsenbeck JP, Larget B, Miller RE, Ronquist F. 2002. Potential applications and pitfalls of Bayesian inference of phylogeny. Systematic Biology 51: 673-688.

Huelsenbeck JP, Rannala B. 2004. Frequentist properties of Bayesian posterior probabilities of phylogenetic trees under simple and complex substitution models. Systematic Biology 53: 904-913.

Huelsenbeck JP, Ronquist FR. 2001. MRBAYES: Bayesian inference of phylogenetic trees. Bioinformatics 17: 754-755.

Ingold CT. 1987. Aerial sporidia of *Ustilago hypodytes* and of *Sorosporium saponariae*. Trans. Brit. Mycol. Soc. 89: 471-475.

Ingold CT. 1999. Two types of basidia in *Urocystis hypoxis* and the implications for smut taxonomy. Mycol. Res. 103: 18-20.

Katoh K, Misawa K, Kuma K, Miyata T. 2002. MAFFT: a novel method for rapid multiple sequence alignment based on fast Fourier transform. Nucleic Acids Research 30: 3059-3066.

Katoh K, Kuma K, Toh H, Miyata T. 2005. MAFFT version 5: improvement in accuracy of multiple sequence alignment. Nucleic Acids Research 33: 511-518.

Lutz M, Bauer R, Begerow D, Oberwinkler F, Triebel D. 2004. *Tuberculina*, rust relatives attack rusts. Mycologia 96: 614-626.

Nagler A. 1986. Untersuchungen zur Gattungsabgrenzung von *Ginanniella* Ciferri und *Urocystis* Rabenhorst sowie zur Ontogenie von *Thecaphora seminis-convolvuli* (Desm.) Ito. Dissertation. Fakultät für Biologie der Eberhard-Karls-Universität Tübingen, pp. 349.

O'Donnell KL. 1992. Ribosomal DNA internal transcribed spacers are highly divergent in the phytopathogenic ascomycete *Fusarium sambucinum* (*Gibberella pulicaris*). Current Genetics 22: 213-220.

O'Donnell KL. 1993. *Fusarium* and its near relatives. – In: Reynolds DR, Taylor JW [eds]. The fungal holomorph: mitotic, meiotic and pleomorphic speciation in fungal systematics, pp. 225-233. CAB International, Wallingford.

Posada D, Crandall KA. 1998. MODELTEST, testing the model of DNA substitution. Bioinformatics 14: 817-818.

Ronquist FR, Huelsenbeck JP. 2003. MRBAYES 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19: 1572-1574.

Vánky K. 1994. European smut fungi. – Gustav Fischer Verlag, Stuttgart, Jena, New York, 570 pp.

Vánky K. 2002. Illustrated Genera of Smut Fungi. 2nd edn. APS Press, St. Paul, Minnesota, USA.

Vánky K. 2008. Taxonomic studies on *Ustilaginomycetes* - 28. Mycotaxon (in prep.).

Vánky K, Lutz M, Bauer R. 2008. About the genus *Thecaphora* (*Glomosporiaceae*) and its new synonyms. Mycol. Progr. (in press).

White TJ, Bruns TD, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In Innis MA, Gelfand DH, Sninsky JJ, White TJ [eds]. PCR protocols, a guide to methods and applications, pp. 315-322. Academic Press, San Diego.

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A new species of *Melanelixia* (*Parmeliaceae*) from China

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Abstract — A new *Melanelixia* species characterized by the presence of cortical hairs and wart-like isidia, *M. subvillosella*, is described from China. *Melanelia subverruculifera* is reported as a new synonym of *Melanelixia villosella*. A key to the nine known *Melanelixia* species is also provided.

Keywords — Asia, lichens, taxonomy

Introduction

The lichen genus *Melanelixia* O. Blanco et al. in the *Parmeliaceae* was segregated from *Melanelia* Essl. based on molecular as well as chemical and morphological data (Blanco et al. 2004). The genus is morphologically characterized by pored or fenestrate epicortex and lecanoric acid as the primary medullary constituent (Blanco et al. 2004, Esslinger 1977). The genus presently includes eight species known in the world: *M. albertana* (Ahti) O. Blanco et al., *M. fuliginosa* (Fr. ex Duby) O. Blanco et al., *M. glabra* (Schaer.) O. Blanco et al., *M. glabroides* (Essl.) O. Blanco et al., *M. huei* (Asahina) O. Blanco et al., *M. subargentifera* (Nyl.) O. Blanco et al., *M. subaurifera* (Nyl.) O. Blanco et al., and *M. villosella* (Blanco et al. 2004). All these *Melanelixia* species except *M. albertana* and *M. subaurifera* have been reported in China (Wei 1991, Abbas et al. 1998, Omar et al. 2004, Chen & Esslinger 2005).

During our study of the lichen flora of China, an interesting species of *Melanelixia* new to science was found. Here we present a brief Latin diagnosis, an extended description, and key to the presently known species of the genus. Five photographs for the new species are provided as well. In addition, as we studied the new species and related taxa, we discovered that *Melanelia subverruculifera* is a synonym of *Melanelixia villosella*.

Materials and methods

The material examined was collected from Northeast China and is preserved in HMAS-L (Herbarium Mycologicum Academiae Sinicae-Lichenes). For the morphological study of the material, a dissecting microscope (Zeiss Stemi SV 11) has been used and the anatomical study was carried using a compound microscope (Zeiss Axioscop 2 plus). For the ultrastructural observations, a scanning electron microscope (Fei Quanta 200) has been used. Lichen substances were identified using the standardized thin layer chromatography techniques of Culberson (1972).

Key to *Melanelixia* species

1a.	Cortical hairs absent	2
1b.	Cortical hairs present	5
2a.	Thallus with isidia, soredia or both	3
2b.	Thallus without isidia or soredia	4
3a.	Isidia fine, 0.1-0.25 mm long and 0.02-0.06 mm in diameter, seldom branched; soredia usually present	***M. subaurifera***
3b.	Isidia larger, mostly 0.2-1mm long and 0.05-0.1 mm in diameter, often branched; soredia never present	***M. fuliginosa***
4a.	Corticolous; upper surface of lobes with obscure to distinctive pseudocyphellae; often with the orange pigment rhodophyscin in the lower medulla	***M. huei***
4b.	Saxicolous; upper surface of lobes without pseudocyphellae; without rhodophyscin	***M. glabroides***
5a.	Thallus with soredia	6
5b.	Thallus without soredia	7
6a.	Soralia marginal and strongly labriform	***M. albertana***
6b.	Soralia laminal and marginal, the laminal ones arising from small, ± hemispherical pustules	***M. subargentifera***
7a.	Thallus without isidia	***M. glabra***
7b.	Thallus with isidia	8
8a.	Isidia cylindrical, often branched and with obvious hyaline hairs at their tips	***M. villosella***
8b.	Isidia wart-like, non-branched and without hairs on their tips	***M. subvillosella***

Taxonomic description

Melanelixia subvillosella H.Y. Wang & J.C. Wei, sp. nov. FIG. 1

MYCOBANK MB 511544

Species haec a M. glabra verrucis et a M. villosella sine trichomis in pagina isidiorum differt.

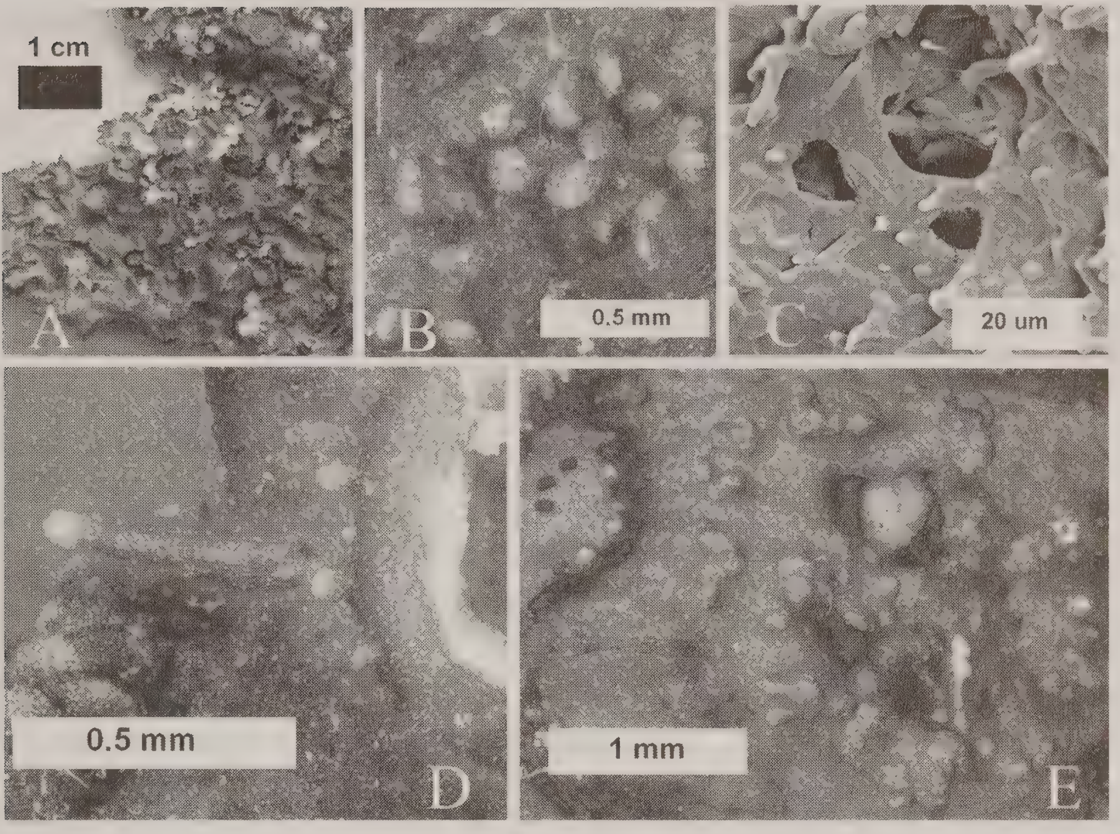

Fig.1 Photographs of *Melanelixia subvillosella*. **A.** Thallus. **B.** Isidia. **C.** SEM photograph, showing the pored and coarse epicortex. **D.** Rhizinae and hairs on an apothecial margin. **E.** Rhizina, papilla and lobules on an apothecial margin.

> *Holotypus a China, Jilin provincia, Mt. Changbaishan, alt. 1100m, ad corticem arborum, X.D. Lu 0211, 24 Jun. 1985 in HMAS-L (077798) conservatur.*

Expanded description — Thallus foliose, 10 cm in diameter (Fig. 1A). Lobes 1-3 mm broad, more or less flat, elongated, sometimes crenulate on the margin, contiguous to imbricate. Upper surface olive-brown to dark-brown; rather shiny at lobe ends, inward becoming dull; with obvious cortical hairs, especially on the lobe ends and the apothecial margins (Fig. 1D); without pseudocyphellae or soredia; isidiate (Fig. 1B), the isidia arising as hemispherical papillae, and then slightly elongating into short claviform isidia (0.2-0.1×0.5-1 mm); lobulate, the lobules short and rounded, marginal to laminal. Lower surface black, often paler at the margin; smooth to wrinkled, dull to slightly shiny; abundantly rhizinate, the rhizines simple to branched, concolorous with the lower surface, to 2 mm long. Lobes 130-160 μm thick, upper cortex 8-12 μm thick; lower cortex 8-11 μm thick. Epicortex pored (pore, 6-16 μm in diameter) and coarse (Fig. 1C). Apothecia common, sessile to short stipitate, concave, to 4 mm in diameter; margin entire when small, soon becoming crenate-papillate and lobulate (Fig. 1E), often with rhizinae (Fig. 1D,E); hymenium 54-70 μm thick, subhymenium 50-70 μm thick; spores 8, globose to ellipsoid, 8-10×5-7 μm, spore wall 1 μm thick. Pycnidia unknown.

Chemistry — Cortex K–, HNO_3–; medulla C+ red, K–, PD–; containing lecanoric acid.

Distribution and substrate — At present, *M. subvillosella* is known only from the type locality; on bark.

Comments — The apothecia with rhizinae and the coarse epicortex distinguish *M. subvillosella* from all the other *Melanelixia* species. The new species can be clearly separated from *M. glabra* by having wart-like isidia and from *M. villosella* by lacking the cortical hairs on the surface of isidia.

Melanelixia villosella (Essl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Mycol. Res. 108(8): 882 (2004)

≡ *Parmelia villosella* Essl., J. Hattori. Bot. Lab. 42: 95 (1977)

= *Parmelia subverruculifera* J.C. Wei & Y.M. Jiang, Acta Phytotax. Sin. 18: 386 (1980) = *Melanelia subverruculifera* (J.C. Wei & Y.M. Jiang) J.C. Wei, Enum. Lich. China: 153 (1991). (syn. nov.) Holotype: CHINA. Tibet, Nielamu, alt. 3840m, 22 Jun 1966, J.C. Wei & J.B. Chen 1899-1 (HMAS-L).

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Literature cited

Abbas A, Wu JN. 1998. Lichens of Xinjiang. 178 pp. Sci-Tech & Hygiene Publishing House of Xinjiang, Urumqi.

Blanco O, Crespo A, Divakar PK, Esslinger TL, Hawksworth DL, Lumbsch HT. 2004. *Melanelixia* and *Melanohalea*, two new genera segregated from *Melanelia* (*Parmeliaceae*) based on molecular and morphological data. Mycological Research 108(8): 873-884.

Chen JB, Esslinger TL. 2005. *Parmeliaceae* (*Ascomycota*) lichens in China's mainland IV. *Melanelia* species new to China. Mycotaxon 93: 71-74.

Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. Jour Chromatogr. 72: 113-125.

Esslinger TL. 1977. A chemosystematic revision of the brown *Parmeliae*. Jour. Hattori Bot. Lab. 42: 1-211.

Omar Z, Keyimu A, Abbas A. 2004. New Chinese records of the lichen genus *Melanelia*. Acta Bot. Yun. 26: 385-386.

Wei JC. 1991. Enumeration of lichens in China. 278 pp. International Academic Publishers. BeiJing.

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The typification of *Colletotrichum gloeosporioides*

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Abstract — The anamorphic species *Colletotrichum gloeosporioides* has never been adequately typified according to modern nomenclatural practice, resulting in uncertainty as to application of the name. A lectotype specimen is therefore designated to preserve current usage, with an epitype also chosen as eligible lectotype material is not preserved in a living state. The epitype strain is described and characterized using morphological and molecular methods. There are three distinct rDNA ITS sequences of the epitype strain in GENBANK, so it has been re-sequenced to confirm the true base-pair structure.

Key words — *Citrus*, phylogeny, plant pathology, species concepts

Introduction

Colletotrichum gloeosporioides is one of the most common and widely distributed plant pathogens in the world (Sutton 1992, Cannon et al. 2000). Since its original description as *Vermicularia gloeosporioides* (Penzig 1882), it has been associated with at least 470 different host genera (Sutton 1980), either as a primary disease-causing organism, or isolated from deteriorated plant parts. It is especially prevalent in the tropics, but has been recorded also from a wide range of temperate and subtropical habitats. The species is well known as a latent pathogen causing post-harvest problems (Prusky & Plumbley 1992), endophytic strains are commonly isolated from symptomless plant parts (Cannon & Simmons 2002, Lu et al. 2004), and reduced-pathogenicity mutants have been explored as control mechanisms for virulent strains (Yakoby et al. 2002). Some strains are highly host-specific, and are used or planned for use as bioherbicides in several parts of the world (Templeton 1992, Weidemann et al. 1998, Watson et al. 2000, Goodwin 2001).

Colletotrichum gloeosporioides has been implicated as an economically important pathogen of a wide range of plants, including *Agavaceae* (Farr et al. 2006), apple (Carvalho et al. 2000), avocado (Mills et al. 1992, Freeman et al. 2000), citrus (Adaskaveg & Förster 2000, Timmer & Brown 2000, Ramos et al. 2006), coffee (Waller & Bridge 2000), mango (Mills et al. 1992, Afanador Kafuri et al. 2003), olive (Martin & Garcia Figueres 1999), papaya (Mills et al. 1992), passion fruit (Afanador Kafuri et al. 2003), proteas (Lubbe et al. 2004), stylosanthes (Manners & He 1997, Munaut et al. 2002), strawberry (Buddie et al. 1999, Smith & Black 1990, Xiao et al. 2004) and yam (Abang et al. 2002, Mignouna et al. 2002).

Colletotrichum gloeosporioides has frequently been confused with other *Colletotrichum* species, especially *C. acutatum* J.H. Simmonds (Brown et al. 1996, Cannon et al. 2000, Jayasinghe et al. 1997), and many older records of *C. gloeosporioides* must be treated with caution. *C. boninense* Moriwaki et al. is also very similar to *C. gloeosporioides* in morphology, but appears from molecular evidence to be more closely related to the *C. dematium* (Pers.) Grove aggregate (Lu et al. 2004, Lubbe et al. 2004). This taxon was originally described from a range of plants in Japan (Morikawi et al., 2003) and is clearly more widely distributed both in host and geographical terms.

Colletotrichum gloeosporioides has frequently been demonstrated to be linked to the teleomorphic species *Glomerella cingulata* (Stoneman) Spauld. & H. Schrenk. Within this taxon, some strains are homothallic and produce the teleomorph in culture, but many are heterothallic and require mating with compatible types. The genetics of sexuality in *C. gloeosporioides* has now been studied for nearly 100 years (Edgerton 1914, Chacko et al. 1994, Correll et al. 2000, Du et al. 2005). There is a rapidly increasing body of knowledge on the genetics of pathogenicity (Dumas et al. 2000, Stephenson et al. 2000).

Throughout the first half of last century, *Colletotrichum* species were assumed to be strongly host-specific. A plethora of "species" were described associated with particular plant genera, frequently with inadequate descriptions and little or no comparison with existing taxa. A major revision of the genus by von Arx (1957) based on morphological rather than associative characteristics reduced the number of accepted species from around 750 to 11, with the vast majority being reduced to synonymy with *C. gloeosporioides*. This dramatic action had a lasting influence on *Colletotrichum* systematics, and nearly fifty years on, many species are still regarded as plurivorous. Since von Arx's revision, further research on the identity and attributes of the genus has resulted in a gradual increase in the number of taxa accepted, and between 40 and 45 species are now generally accepted (Sutton 1992, Cannon et al. 2000).

A basic problem with *Colletotrichum* systematics at the beginning of the twenty-first century is an increasing imbalance in the morphological, biological and genetic variation accepted within taxa recognized at the species level. The new era of molecular systematics has accelerated this trend, as apparently monophyletic (and sometimes clonal) populations with defined pathological effects are regarded as distinct segregate species, with the remaining populations within the aggregate species being recognized as paraphyletic. This is highly confusing to the applied biologist, and makes communication concerning the aggregate ambiguous. The situation is further complicated by the segregate species themselves having significantly different ranges of variation.

Within the *C. gloeosporioides* aggregate, a number of morphologically indistinguishable segregate species have been recognized and almost certainly, many more remain to be defined. *C. kahawae* J.M. Waller & Bridge is a near-clonal organism that causes the economically devastating coffee berry disease in eastern Africa (Sreenivasaprasad et al. 1993, Waller et al. 1993). It was distinguished from generic *C. gloeosporioides* strains that also occur on coffee (usually referred to collectively as *C. coffeanum* F. Noack) using pathological and biochemical characters. *C. fragariae* A.N. Brooks is a pathogen of strawberry plants in North America which is restricted in its genetic range but includes distinct mitochondrial and ribosomal idiomorphs (Buddie et al., 1999), some of which are homothallic and produce a teleomorph. There are undoubtedly other segregates within the *C. gloeosporioides* aggregate which remain to be fully characterized using molecular techniques, including recently described taxa such as *C. nymphaeae* (Pass.) Aa (van der Aa 1978), *C. nupharicola* D.A. Johnson et al. (Johnson et al. 1997) and *C. xanthorrhoeae* R.G. Shivas et al. (Shivas et al. 1998). The *C. musae* (Berk. & M.A. Curtis) Arx cluster has still to be adequately separated in morphological and molecular terms from *C. gloeosporioides* in its broad sense (Morikawi et al. 2003).

The paraphyly of *C. gloeosporioides* as it is currently circumscribed has been widely recognized (e.g. Sherriff et al. 1994, Sreenivasaprasad et al. 1996, Johnston & Jones 1997, Morikawi et al. 2003, Lubbe et al. 2004). The recognition of more segregate taxa will further complicate the definition of *C. gloeosporioides*, and the process of assigning rank to the segregates remains to be resolved. There is some evidence from ribosomal sequence polymorphism that the *C. gloeosporioides* aggregate is broadly equivalent in variation to single species concepts in many other fungal genera (Cannon et al. 2000, Morikawi et al. 2003). Evidence from mating-type gene sequences also supports the recognition of *C. gloeosporioides* as a single species (Du et al. 2005). Currently a clear preference exists amongst applied biologists to refer to the segregate taxa as species rather than using names at infraspecific rank. Whatever the position in the taxonomic hierarchy of the *C. gloeosporioides* aggregate in the future, there is a need to fix the application of the name through typification.

Materials and methods

Isolates—The lectotype was chosen from original material in Penzig's herbarium, specimens from which are preserved in the U.S. National Fungus Collections (BPI). The epitype specimen of *Colletotrichum gloeosporioides* was selected from a set of strains isolated from *Citrus* species from southern Italy, and is preserved as a dried culture in the CABI herbarium (IMI). Subcultures from the epitype are preserved in the living collections of CABI (IMI), the Centraalbureau voor Schimmelcultures (CBS) and the University of Stellenbosch culture collection (STE–U).

Culture and morphology—The epitype strain was grown under various conditions for morphological analysis. 14-day old cultures grown at ambient temperature (ca 20°C) on PCA (potato-carrot agar) and PDA (potato-dextrose agar) (Kirk et al. 2001) under near-ultraviolet (NUV) light with 12 hr light/dark cycles were used for general observations of cultural features. Squash mounts were prepared using lactic acid, acid fuchsin and cotton blue as stain/mounting media. 12-day old slide cultures (Riddell 1950) were used for measurements and images of appressoria. Growth rates and cardinal temperature requirements for growth were determined for isolates plated onto PDA in 90 mm Petri dishes and incubated in the dark for 7 d at seven different temperatures, ranging from 5 to 35 C at 5° intervals. Three plates were used for each isolate at each temperature. Radial mycelial growth was measured for each plate and the mean calculated at each temperature to determine the growth rates for each species. Colours conform to the standards in Rayner (1970). Macroscopic images were obtained using an Olympus 2020M digital camera, and microscopic images with a JVC 75Y digital camera linked to a Syncroscopy Auto-Montage software system.

Conidial measurement—Conidial measurements were obtained using slide preparations mounted in water and cotton blue/lactic acid. Conidial images were selected manually using an oil immersion objective, and stored within a Leica Quantimet 600 image analysis apparatus. Shape and size of conidia were analyzed using a series of 64 ferets (lines through the centre of gravity of the object), with length and breadth corresponding to the longest and shortest feret respectively.

Phylogenetic analysis—The ITS sequences listed in Table 1 were acquired from GenBank and aligned with Clustal W (Thompson et al 1994). Manual improvement of the final alignment based on visual inspection was made where necessary. Neighbour joining analysis was performed with PHYLIP v3.6 (Felsenstein, 2004) using the Kimura-2-parameter substitution model.

Alignment gaps were treated as missing character states and all characters were unordered and of equal weight. The resulting tree was evaluated with 1000 bootstrap replications to test the clade stability. Resulting trees were printed with TreeView Version 1.6.6 (Page 1996).

Typification and taxonomy

Unequivocal holotype material of *Vermicularia gloeosporioides* no longer exists. None of the specimens in Saccardo's herbarium (Gola 1930; Terzo in litt.), where Penzig's specimens were deposited, can be considered as type material. There are however seven presumed duplicate specimens from Penzig's collections identified as this species in the US National Fungus Collections (BPI), which are potential lectotypes. Six of these were collected by Penzig himself between July 1881 and September 1882. The date of publication of the name *V. gloeosporioides* is not absolutely certain. Stafleu & Cowan (1983) state that Penzig's Fungi agrumicoli (reprinted from Michelia) has a publication date of July 1882 on the title page, though production delays could have led to its appearance some months afterwards. For the purpose of identifying type material, the signature date of June 1882 at the end of Penzig's preface is relevant, which implies that collections on which the name is based must have been made before that date. See Pennycook (1983) for more information on the publication of this name and the subsequent combination *Colletotrichum gloeosporioides*.

Only three of the collections were made prior to June 1882 and can therefore be considered as likely syntypes. BPI 738338 was collected from the Botanic Garden in Padua in May 1882 and has a note indicating that it is part of the type, but it may well have been gathered after the description was written and no longer contains conidia. BPI 738333, collected in September 1881 from La Mortola (near Ventimiglia), is accompanied by a hand-written note (author unknown) stating that it is "typica", but again no conidia are present. BPI 738336 was collected by Penzig from Cattajo (one of the localities cited in the original publication) on 4 July 1881. It consists of a single leaf fragment with typical anthracnose symptoms at the tip with a number of fertile conidiomata but apparently no accompanying setae. This therefore appears to constitute the only surviving syntype that is appropriate to use for lectotypification.

The material in BPI 738336 is very sparse, so no attempt was made to extract DNA. Designation of an epitype is therefore desirable, and a search was conducted for an appropriate strain. The following criteria were taken into account:

Morphological and cultural characteristics to conform to modern descriptions of *C. gloeosporioides* (Mordue 1971, Baxter et al. 1983, Sutton 1980, 1992).

Table 1. ITS sequences used in the phylogenetic analysis of *Colletotrichum gloeosporioides*

GENBANK reference	Strain reference	Identification in GENBANK	Country of origin	Host plant	Reference
EU371022	IMI 356878	*Colletotrichum gloeosporioides* (EPITYPE)	Italy	*Citrus sinensis*	This paper
AY376532	CBS 112999 (=IMI 356878)	*Colletotrichum gloeosporioides*	Italy	*Citrus sinensis*	Lubbe et al. (2004)
AF090855	CECT 21073 (= IMI 356878)	*Colletotrichum gloeosporioides*	Italy	*Citrus sinensis*	Martin & Garcia Figueres (1999)
AJ536229	IMI 356878	*Colletotrichum gloeosporioides*	Italy	*Citrus sinensis*	Martinez Culebras et al. (2003)
AB105971	MAFF 306553	*Glomerella cingulata*	Japan	*Fagopyrum esculentum*	Morikawi et al. (2002)
AB087219	MAFF 306553	*Glomerella cingulata*	Japan	*Fagopyrum esculentum*	Morikawi et al. (2003)
AY423476	Tm7-3	*Glomerella cingulata*	Taiwan	*Taxus mairei*	unpublished
AF207792	AVO-37-4B	*Colletotrichum gloeosporioides*	Israel	*Persea americana*	Freeman et al. (2000)
AY266395	CMUBE 1850	*Glomerella cingulata*	Thailand	*Musa acuminata*	Photita et al. (2005)
AJ311884	CgS6	*Colletotrichum gloeosporioides*	Nigeria	*Dioscorea rotundata*	Abang et al. (2002)
AF451905	CS89	*Glomerella cingulata*	Australia	*Stylosanthes scabra*	Ford et al. (2004)
AF488777	IMI 383016	*Glomerella cingulata*	India	*Hevea brasiliensis*	unpublished
AF534466	M 13	*Glomerella cingulata*	Colombia	*Coffea arabica*	unpublished
AF272779	APL 7	*Glomerella cingulata*	USA	*Malus domestica*	Freeman et al. (2001)
AF489568	Cg-st1159.5d	*Glomerella cingulata*	Spain	*Fragaria x ananassa*	Denoyes-Rothan et al. (2003)
AJ311882	Cg33	*Colletotrichum gloeosporioides*	Nigeria	*Dioscorea rotundata*	Abang et al. (2002)
AJ301988	BBA 71473	*Colletotrichum gloeosporioides*	Not specified	*Citrus aurantium*	Nirenberg et al. (2002)
AY438550	IMI 388809	*Colletotrichum gloeosporioides*	Guyana	*Catostemma fragrans*	Lu et al. (2004)
AY438545	IMI 377094	*Glomerella cingulata*	Guyana	*Catostemma fragrans*	Lu et al. (2004)
AY438546	IMI 377198	*Glomerella cingulata*	Guyana	*Mora excelsa*	Lu et al. (2004)
AY438551	IMI 376876	*Glomerella cingulata*	Guyana	*Chlorocardium rodiei*	Lu et al. (2004)
AY438548	IMI 377096	*Glomerella cingulata*	Guyana	*Catostemma fragrans*	Lu et al. (2004)

AF521198	MAN-53	*Glomerella cingulata*	Colombia	*Mangifera indica*	Afanador-Kafuri et al. (2003)
AY376534	IMI 266803	*Colletotrichum gloeosporioides*	Belize	*Citrus* sp.	Lubbe et al. (2004)
AY376536	CBS 113192	*Colletotrichum gloeosporioides*	South Africa	*Protea cynaroides*	Lubbe et al. (2004)
AJ301986	ATCC 20538	*C. g.* f.sp. *aeschynomenes*	USA	*Aeschynomene virginica*	Nirenberg et al. (2002)
AJ301912	BBA 70340	*Colletotrichum fragariae*	USA	*Fragaria* x *ananassa*	Nirenberg et al. (2002)
AY376544	IMI 324985	*Colletotrichum fragariae*	USA	*Fragaria* x *ananassa*	Lubbe et al. (2004)
AY376540	IMI 319424	*Colletotrichum kahawae*	Kenya	*Coffea arabica*	Lubbe et al. (2004)
AJ301929	BBA 70365	*Colletotrichum musae*	Not specified	*Musa* sp.	Nirenberg et al. (2002)
AJ301904	BBA 62471	*Colletotrichum musae*	Not specified	*Musa* sp.	Nirenberg et al. (2002)
AY376510	IMI 117617	*Colletotrichum acutatum*	Australia	*Carica papaya*	Lubbe et al. (2004)
AY376521	CBS 110779	*Colletotrichum boninense*	South Africa	*Eucalyptus* sp.	Lubbe et al. (2004)
AY376526	IMI 56173	*Colletotrichum capsici*	Tanzania	*Arachis hypogaea*	Lubbe et al. (2004)
AY376527	IMI 196464	*Colletotrichum caudatum*	India	*Cymbopogon martinii*	Lubbe et al. (2004)
AY376528	IMI 61249	*Colletotrichum coccodes*	Zimbabwe	*Lycopersicon esculentum*	Lubbe et al. (2004)
AY376531	IMI 80025	*Colletotrichum dematium*	unknown	*Peperomia* sp.	Lubbe et al. (2004)
AB105959	MAFF 238453	*Colletotrichum destructivum*	unknown	unknown	unpublished
AJ536231	IMI 347765	*Colletotrichum falcatum*	Bangladesh	*Saccharum officinarum*	Martinez Culebras et al. (2003)
AJ301938	BBA 70535	*Colletotrichum fuscum*	Germany	*Digitalis lanata*	Nirenberg et al. (2002)
AY376539	IMI 84302	*Colletotrichum graminicola*	Zimbabwe	*Zea mays*	Lubbe et al. (2004)
AB105955	MAFF 305970	*Colletotrichum higginsianum*	Japan	*Brassica pekinensis*	Morikawi et al. (2002)
AY376541	IMI 368075	*Colletotrichum orbiculare*	Argentina	*Xanthium spinosum*	Lubbe et al. (2004)
AY376542	IMI 372541	*Colletotrichum sublineolum*	Ethiopia	*Sorghum bicolor*	Lubbe et al. (2004)
AJ301941	CBS 158.83	*Colletotrichum trifolii*	Netherlands	*Trifolium* sp.	Lubbe et al. (2004)
AY376543	IMI 217517	*Colletotrichum truncatum*	Gambia	*Arachis hypogaea*	Lubbe et al. (2004)
AJ301958	BBA 65483	*Colletotrichum lindemuthianum*	unknown	*Phaseolus* sp.	unpublished

Geography and climate to correspond to information in the original publication
Host plant to be similar to that stated in the original publication
Pathogenic activity to be weak or intermediate, rather than strong
Cultures to be stored in multiple publically accessible collections
Molecular analysis to place the strain within the *C. gloeosporioides* aggregate

The overall aim of the selection process was to designate an epitype that is typical of the species in both morphological and molecular terms, and which is a generalized strain rather than a strong pathogen, which might be segregated from the bulk of the species aggregate in the future. Accordingly, the strain IMI 356878 is formally designated below as epitype of *Vermicularia gloeosporioides*. A comprehensive description, illustrations and molecular analysis of the strain are provided.

Colletotrichum gloeosporioides (Penz.) Penz. & Sacc.,
Atti Ist. Veneto Sci. lett. ed Arti Série 6, 2: 670, 1884. **Fig. 1**

Vermicularia gloeosporioides Penz., Michelia 2: 450, 1882.

Typification: Italy: Veneto, Padova, Cattajo, on a living leaf of *Citrus* sp., 4 July 1881, *Penzig* (BPI 738336 – **syntype** of *Vermicularia gloeosporioides*, here designated **lectotype**). Italy: Calabria, Lamezia Terme, isolated from a necrotic spot on leaves of *Citrus sinensis*, autumn 1991, A.M. Pennisi & G.E. Agosteo (IMI 356878 – living and dried culture, here designated **epitype** of *Vermicularia gloeosporioides* Penzig; = CBS 953.97, 112999; CECT 21073; STE-U 4295 – living cultures derived from the epitype).

Colonies on PCA and SNA hardly pigmented, with sparse hyaline aerial mycelium. Colonies on PDA Pale Olivaceous Grey (120) to Olivaceous Grey (121), merging to Grey Olivaceous (107) in the centre, reverse Iron Grey (122) to Olivaceous Black (108), with copious floccose to woolly aerial mycelium. Cardinal temperature requirements for growth on all media min 5 C, opt 25 C, max 35 C, mean daily growth rate 26.5 mm/d at 25 C. Conidiomata with masses of orange conidia, forming irregular masses of dark brown angular cells from which setae and conidiophores are produced. Setae 40–120 µm long, 1- to 5-septate, mid brown at base, pale brown at the bluntly rounded apex, tapering gradually from a base 4–6 µm diam, to 2–4 µm diam at the apex. Conidiophores irregularly branched, frequently with the lower portion pigmented. Conidiogenous cells 10–25 x 2.5–4 µm, subcylindrical, straight to curved, hyaline, smooth, tapering towards a truncate apex with visible periclinal thickening, collarette absent or very inconspicuous, proliferating percurrently. Conidia hyaline, smooth, guttulate, subcylindrical with bluntly rounded ends and slightly flattened base, some slightly constricted in the middle of the conidium. Conidial dimensions in water: 12–17 (–23.5) ×

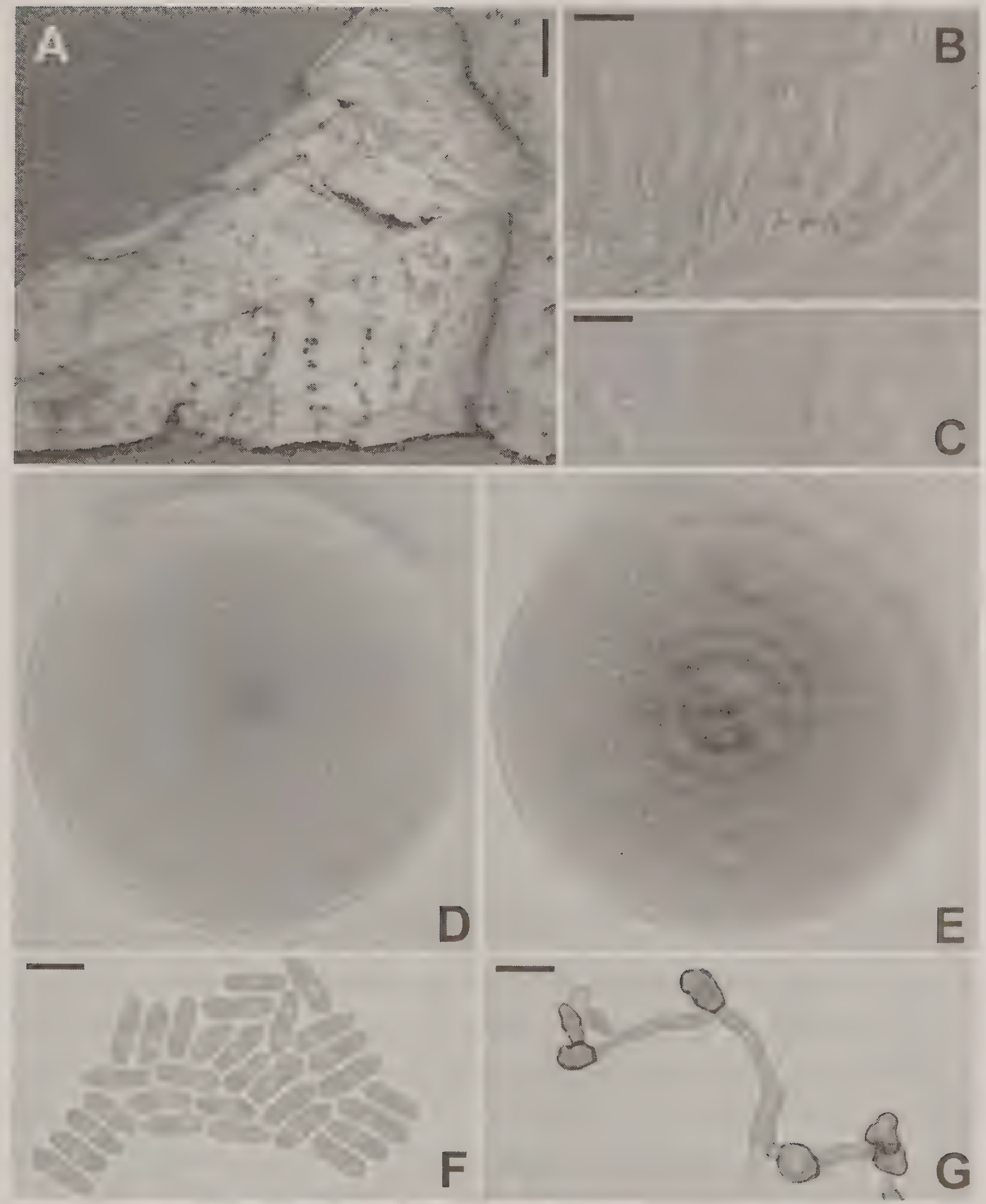

Fig. 1. *Colletotrichum gloeosporioides*. A-C. Lectotype (BPI 738336). A. Colonies at leaf tip of *Citrus* sp.; bar = 1 mm. B. Conidiogenous cells mounted in lactic acid; bar = 10 µm. C. Conidia mounted in lactic acid; bar = 10 µm. D-G. Epitype (IMI 356878). D. Colony growth after 14 d on PCA. E. Colony growth after 14 d on PDA. F. Conidia mounted in lactic acid; bar = 10 µm. G. Appressoria mounted in lactic acid; bar = 10 µm.

4.5–6 µm [*n* = 50, mean = 14.4 × 5.6 µm, l/w ratio = 2.6]; in lactic acid/cotton blue: (10.5–) 11–15 × 4.5–5.5 µm [*n* = 50, mean = 12.6 x 5.9 µm, l/w ratio = 2.6]. Germinating conidia forming one or two, seldom more germ tubes,

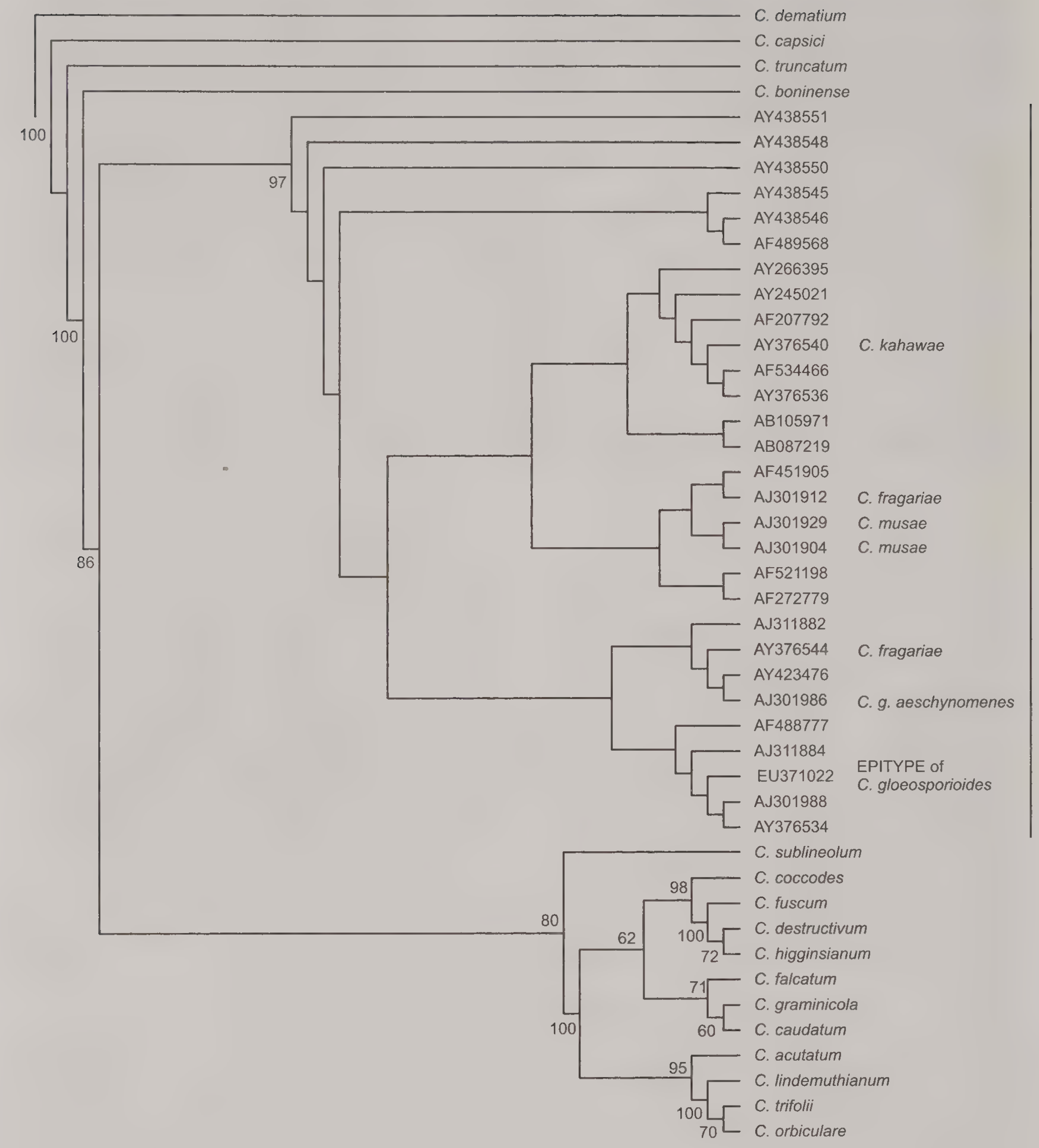
C. dematium
C. capsici
C. truncatum
C. boninense
AY438551
AY438548
AY438550
AY438545
AY438546
AF489568
AY266395
AY245021
AF207792
AY376540
C. kahawae
AF534466
AY376536
AB105971
AB087219
AF451905
AJ301912
C. fragariae
AJ301929
C. musae
AJ301904
C. musae
AF521198
AF272779
AJ311882
AY376544
C. fragariae
AY423476
AJ301986
C. g. aeschynomenes
AF488777
AJ311884
EU371022
EPITYPE of
C. gloeosporioides
AJ301988
AY376534
C. sublineolum
C. coccodes
C. fuscum
C. destructivum
C. higginsianum
C. falcatum
C. graminicola
C. caudatum
C. acutatum
C. lindemuthianum
C. trifolii
C. orbiculare
100
97
100
86
98
80
62
100
72
71
60
100
95
100
70

Fig. 2. Tree obtained from neighbour joining analysis of ITS1, 5.8S and ITS2 sequence data of *Colletotrichum gloeosporioides* and related taxa. The vertical bar marks the extent of the *C. gloeosporioides* aggregate.

usually formed near the apices; when only one germ tube is formed the process is preceded by formation of a median septum in the conidium, after which the distal cell usually collapses at once. GERM TUBES 2.4–4.5(–6.5) µm diam, hyaline, septate, soon branching, often forming single holoblastic secondary conidia or appressoria. APPRESSORIA 7.2–8.6(–12) x 4.7–6.0 µm, aseptate, clavate, sometimes somewhat attenuated at the apex, broadest in the middle, regular in outline or irregular and weakly lobed, the walls thickened, pale to dark olivaceous brown, with one distinct circular pore, usually containing one large guttule. TELEOMORPH not produced in culture.

Discussion

The analysis of ITS sequences (Fig. 2) is intended to confirm firstly that the epitype strain chosen falls within the *C. gloeosporioides* aggregate using that character suite, and secondly that other named taxa (see below) also belong within that broad species concept. Discrete lineages may exist within the *C. gloeosporioides* aggregate, but the phylogenetic signal (as indicated by the bootstrap values) is insufficient from this gene portion alone to identify them with confidence. The difficulties in analyzing these data appear to be associated with the limited extent and also the localization of variation in the ITS sequences in *Colletotrichum*, with most located in a single region that gives rise to two distinct secondary structures for the gene (Bridge et al., in press). The usual statistical support methods of bootstrapping and jacknifing involve a random resampling or reduction of the data. As the variation is not randomly distributed through the sequence, the potential differences between individual sequences can vary widely when resampled, resulting in poor consensus.

Colletotrichum musae has been considered a distinct species from ITS sequence evidence (e.g. Sreenivasaprasad et al. 1996), but its separation from the *C. gloeosporioides* aggregate is not confirmed here. In morphological terms, *C. musae* tends to have slightly wider conidia and more irregularly shaped appressoria than *C. gloeosporioides* (Sutton 1980), but the differences are minimal. It is very difficult to distinguish true strains of *C. musae* from non-specific *C. gloeosporioides* strains on banana using morphological characteristics. Epitypification of *C. musae* is also required to fix application of the name.

Colletotrichum fragariae may be a distinct taxon within the *C. gloeosporioides* aggregate, but there are strong indications that the species is not confined to strawberry, has a much wider distribution than hitherto believed (Buddie et al. 1999), and it may require redefinition. *C. gloeosporioides* f. *stylosanthis* Munaut (Munaut et al. 2002) appears to be indistinguishable from *C. fragariae* in ITS sequence, but more work is needed to clarify relationships between the two taxa bearing in mind their economic importance.

The coffee berry pathogen *Colletotrichum kahawae* (Waller et al. 1993) is also confirmed as belonging to the *C. gloeosporioides* aggregate. This is an economically important and host-specific taxon, but as suspected by Sreenivasaprasad et al. (1993) and Cannon et al. (2000) it is inappropriately recognized at species level according to current systematics practice. At present, no generally accepted taxonomic category exists for pathogenic "species" such as *C. kahawae*, resulting in major obstacles to scientific communication between taxonomists and pathologists. The assemblages "forma specialis" and "pathovar" do not have formal acceptance as taxonomic ranks, and pathologists have used the terms in different ways. Standardization would be beneficial, especially if linked to phylogenetic signal as well as pathogenic activity.

Disturbingly, sequences of the *Colletotrichum gloeosporioides* epitype strain submitted to GENBANK by different research groups differ in their base-pair composition. Three independent sequences of the epitype strain (Martin & Garcia Figueres 1999, Martinez Culebras et al. 2003, Lubbe et al. 2004) were found to be distinct, in one case with 4 apparent polymorphisms (1.5% of the total sequence). This level of difference is of great concern in a genus such as *Colletotrichum* where reported ITS sequence differences between species are generally less than 5% (Cannon et al. 2000). These results underline the need to interpret sequence data with care, whether generated de novo or extracted from public databanks.

In the case of the *C. gloeosporioides* epitype strain, the sequences AY376532 and AF090855 differ by only one base, while AY536229 shows four polymorphisms relative to the first two. The polymorphism in AF090855 relative to AY376532 involves an additional cytosine base that is not present in any of the other *Colletotrichum* sequences, so we are reasonably confident that this represents a sequencing error. We therefore resequenced the ITS region of the *C. gloeosporioides* epitype strain seven times from two separate DNA extractions, one from a living culture and the other direct from a lyophilized sample. The ITS sequences generated were identical, and a single contiguous sequence (including overhangs from forward and reverse strand reads) from this set has been made available in GENBANK as EU371022. This sequence is indistinguishable from one of the previously published sequences, AY376532, apart from small differences in the overall extent of the sequence into the surrounding genes. We therefore recommend acceptance of EU371022 and AY376532 as definitive ITS sequences of the epitype of *Colletotrichum gloeosporioides*.

ITS sequence is a powerful tool for phylogenetic reconstruction due to ease of acquisition and the extensive library of existing sequences, but it is too highly conserved to provide ideal markers for infraspecific classifications in *Colletotrichum*. Assuming that there are genuine sub-lineages below the level of species in *Colletotrichum* that are not entirely obscured by hybridization events, the search should be continued for other genes or gene fragments that can provide a more reliable indication of phylogeny.

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Literature cited

Aa HA van der. 1978. A leaf spot disease of *Nymphaea alba* in the Netherlands. – Netherlands Journal of Plant Pathology 84: 109-115.

Abang MM, Winter S, Green KR, Hoffmann P, Mignouna HD, Wolf GA. 2002. Molecular identification of *Colletotrichum gloeosporioides* causing yam anthracnose in Nigeria. Plant Pathology 51: 63-71.

Adaskaveg JE, Förster H. 2000. Occurrence and management of anthracnose epidemics caused by *Colletotrichum* species on tree fruit crops in California. In Prusky D, Freeman S, Dickman MB (eds) *Colletotrichum.* Host Specificity, Pathology, and Host-Pathogen Interaction. APS Press, St Paul, USA pp. 317-336.

Afanador-Kafuri L, Minz D, Maymon M, Freeman S. 2003. Characterization of *Colletotrichum* isolates from tamarillo, *Passiflora* and mango in Colombia and identification of a unique species from the genus. Phytopathology 93: 579-587.

Arx JA von. 1957. Die Arten der Gattung *Colletotrichum*. Phytopathologische Zeitschrift 29: 413-468.

Baxter AP, Westhuizen GCA van der, Eicker A. 1983. Morphology and taxonomy of South African isolates of *Colletotrichum*. South African Journal of Botany 2: 259-289.

Bridge PD, Cannon PF, Buddie AG, Baker M, Borman AM. Domain II hairpin structure in ITS1 sequences as an aid in differentiating recently evolved animal and plant pathogenic fungi. Mycopathologia, in press.

Brown AE, Sreenivasaprasad S, Timmer LW. 1996. Molecular characterization of slow-growing orange and key lime anthracnose strains of *Colletotrichum* from *Citrus* as *C. acutatum*. Phytopathology 86: 523-527.

Buddie AG, Martinez-Culebras P, Bridge PD, Garcia MD, Querol A, Cannon PF, Monte E. 1999. Molecular characterization of *Colletotrichum* strains derived from strawberry. Mycological Research 103: 385-394.

Cannon PF, Bridge PD, Monte E. 2000. Linking the past, present and future of *Colletotrichum* systematics. In Prusky D, Freeman S, Dickman MB (eds) *Colletotrichum.* Host Specificity, Pathology, and Host-Pathogen Interaction. APS Press, St Paul, USA pp. 1-20.

Cannon PF, Simmons CM. 2002. Diversity and host preference of leaf endophytic fungi in the Iwokrama Forest Reserve, Guyana. Mycologia 94: 210-220.

Carvalho FMS, Leite Junior RP, Ueno B. 2000. Pathogenic characterization of *Colletotrichum* spp. associated with apple diseases in southern Brazil. Fitopatologia Brasileira 25: 72-78.

Chacko RJ, Weidemann GJ, TeBeest DO, Correll JC. 1994. The use of vegetative compatibility and heterokaryosis to determine potential asexual gene exchange in *Colletotrichum gloeosporioides*. Biological Control 4: 382-389.

Correll JC, Guerber JC, Wasilwa LA, Sherrill JF, Morelock TE. 2000. Inter- and intra-species variation in *Colletotrichum* and mechanisms which affect population structure. In Prusky D, Freeman S, Dickman MB (eds) *Colletotrichum.* Host Specificity, Pathology, and Host-Pathogen Interaction. APS Press, St Paul, USA pp. 145-179.

Denoyes-Rothan B, Guerin G, Delye C, Smith B, Minz D, Maymon M, Freeman S. 2003. Genetic diversity and pathogenic variability among isolates of *Colletotrichum* from strawberry. Phytopathology 93: 219-228.

Du M-z, Schardl CL, Nuckles EM, Vaillancourt LJ. 2005. Using mating-type gene sequences for improved phylogenetic resolution of *Colletotrichum* species complexes. Mycologia 97: 641-658.

Dumas B, Boudart G, Centis S, Esquerré-Tugayé M-T. 2000. The endopolygalacturonases of *Colletotrichum lindemuthianum*: molecular characterization, gene expression and elicitor activity. In Prusky D, Freeman S, Dickman MB (eds) *Colletotrichum*. Host Specificity, Pathology, and Host-Pathogen Interaction. APS Press, St Paul, USA pp. 195-204.

Edgerton CW. 1914. Plus and minus strains in the genus *Glomerella*. American Journal of Botany 1: 224-254.

Farr DF, Aime MC, Rossman AY, Palm, ME. 2006. Species of *Colletotrichum* on *Agavaceae*. Mycological Research 110: 1395-1408.

Felsenstein J. 2004. PHYLIP (Phylogeny Inference Package) version 3.6. Distributed by the author. Department of Genome Sciences, University of Washington, Seattle.

Ford R, Banniza S, Photita W, Taylor PWJ. 2004. Morphological and molecular discrimination of *Colletotrichum truncatum* causing anthracnose on lentil in Canada. Australasian Plant Pathology 33: 559-569.

Freeman S, Minz D, Jurkevitch E, Maymon M, Shabi E. 2000. Molecular analyses of *Colletotrichum* species from almond and other fruits. Phytopathology 90: 608-614.

Freeman S, Minz D, Maymon M, Zveibil A. 2001. Genetic diversity within *Colletotrichum acutatum* sensu Simmonds. Phytopathology 91: 586-592.

Gola G. 1930. L'Erbario Micologico di P.A. Saccardo. Catalogo. Tipografia Editrice Antoniana, Padova. 328 pp.

Goodwin PH. 2001. A molecular weed-mycoherbicide interaction: *Colletotrichum gloeosporioides* f. sp. *malvae* and round-leaved mallow, *Malva pusilla*. Canadian Journal of Plant Pathology 23: 28-35.

Jayasinghe CK, Fernando THPS, Priyanka UMS. 1997. *Colletotrichum acutatum* is the main cause of *Colletotrichum* leaf disease of rubber in Sri Lanka. Mycopathologia 137: 53-56.

Johnson DA, Carris LM, Rogers JD. 1997. Morphological and molecular characterization of *Colletotrichum nymphaeae* and *C. nupharicola* sp. nov. on water-lilies (*Nymphaea* and *Nuphar*). Mycological Research 101: 641-649.

Johnston PR, Jones D. 1997. Relationships among *Colletotrichum* isolates from fruit-rots assessed using rDNA sequences. Mycologia 89: 420-430.

Kirk PM, Cannon PF, David JC, Stalpers JA (eds). 2001. Ainsworth & Bisby's Dictionary of the Fungi edn 9. CAB International, Wallingford, UK. 655 pp.

Lu G-z, Cannon PF, Reid A, Simmons CM. 2004. Diversity and molecular relationships of endophytic *Colletotrichum* isolates from the Iwokrama Forest Reserve, Guyana. Mycological

Research 108: 53-63.

Lubbe CM, Denman S, Cannon PF, Groenewald JZ, Lamprecht SC, Crous PW. 2004. Characterization of *Colletotrichum gloeosporioides* and similar species associated with anthracnose and dieback of *Proteaceae*. Mycologia 96: 1268-1279.

Manners JM, He C. 1997. Recent advances in studies of anthracnose of *Stylosanthes*. IV. Molecular approaches to studies of *Colletotrichum gloeosporioides* causing anthracnose of *Stylosanthes* in Australia. Tropical Grasslands 31: 435-444.

Martin MP, Garcia Figueres F. 1999. *Colletotrichum acutatum* and *C. gloeosporioides* cause anthracnose on olives. European Journal of Plant Pathology 105: 733-741.

Martinez Culebras PV, Querol AA, Suarez Fernandez MB, Garcia-Lopez MD, Barrio E. 2003. Phylogenetic relationship among *Colletotrichum* pathogens of strawberry and design of PCR primers for their identification. Journal of Phytopathology 151: 135-143.

Mignouna HD, Abang MM, Onasanya A, Asiedu R. 2002. Identification and application of RAPD markers for anthracnose resistance in water yam (*Dioscorea alata*). Annals of Applied Biology 141: 61-66.

Mills PR, Hodson A, Brown AE. 1992. Molecular differentiation of *Colletotrichum* isolates infecting tropical fruits. In Bailey JA, Jeger MJ (eds) *Colletotrichum:* Biology, Pathology and Control. CAB International, Wallingford, UK pp. 269-288.

Mordue JEM. 1971. *Glomerella cingulata*. CMI Descriptions of Pathogenic Fungi & Bacteria no. 315. Commonwealth Mycological Institute, Kew, UK.

Moriwaki J, Tsukiboshi T, Sato T. 2002. Grouping of *Colletotrichum* species in Japan based on rDNA sequences. Journal of General Plant Pathology 68: 307-320.

Morikawi J, Sato T, Tsukiboshi T. 2003. Morphological and molecular characterization of *Colletotrichum boninense* sp. nov. from Japan. Mycoscience 44: 47-53.

Munaut F, Hamaide N, Maraite H. 2002. Genomic and pathogenic diversity in *Colletotrichum gloeosporioides* from wild native Mexican *Stylosanthes* spp., and taxonomic implications. Mycological Research 106: 579-593.

Nirenberg HI, Feiler U, Hagendorn G. 2002. Description of *Colletotrichum lupini* comb. nov. in modern terms. Mycologia 94: 307-320.

Page RDM. 1996. TREEVIEW: an application to display phylogenetic trees on personal computers. Computers in Applied Bioscience 12: 357-358.

Pennycook SR. 1983. *Colletotrichum gloeosporioides* (Penzig) Penzig et Saccardo. Mycotaxon 16: 507-508.

Penzig AGO. 1882. Funghi agrumicoli. Contribuzione allo studio dei funghi parassiti degli agrumi. Michelia 2: 385-508 + 136 pl.

Photita W, Taylor PWJ, Ford R, Hyde KD, Lumyong S. 2005. Morphological and molecular characterization of *Colletotrichum* species from herbaceous plants in Thailand. Fungal Diversity 18: 117-133.

Prusky D, Plumbley RA. 1992. Quiescent infections of *Colletotrichum* in tropical and subtropical fruits. In Bailey JA, Jeger MJ (eds) *Colletotrichum:* Biology, Pathology and Control. CAB International, Wallingford, UK pp. 289-307.

Ramos AP, Merali Z, Talhinhas P, Sreenivasaprasad S, Oliveira H. 2006. Molecular and morphological characterisation of *Colletotrichum* species involved in citrus anthracnose in Portugal. Bulletin OILB/SROP 29: 317-326.

Rayner RW. 1970. A Mycological Colour Chart. Commonwealth Mycological Institute and British Mycological Society, Kew, UK.

Riddell RW. 1950. Permanent stained mycological preparations obtained by slide culture. – Mycologia 42: 265-270.

Sherriff C, Whelan MJ, Arnold GM, Lafay G-F, Brygoo Y, Bailey JA. 1994. Ribosomal DNA sequence analysis reveals new species groupings in the genus *Colletotrichum*. Experimental Mycology 18: 121-138.

Shivas RG, Bathgate J, Podger FD. 1998. *Colletotrichum xanthorrhoeae* sp. nov. on *Xanthorrhoea* in Western Australia. Mycological Research 102: 280-282.

Smith BJ, Black LL. 1990. Morphological, cultural and pathogenic variation among *Colletotrichum* species isolated from strawberry. Plant Disease 74: 69-76.

Sreenivasaprasad S, Brown AE, Mills PR. 1993. Coffee berry disease pathogen in Africa: genetic structure and relationship to the group species *Colletotrichum gloeosporioides*. Mycological Research 97: 995-1000.

Sreenivasaprasad S, Mills PR, Meehan BM, Brown AE. 1996. Phylogeny and systematics of 18 *Colletotrichum* species based on ribosomal DNA spacer sequences. Genome 39: 499-512.

Stafleu FA, Cowan RS. 1983. Taxonomic Literature. Edn 2, vol. IV: P-Sak. Bohn, Scheltema & Holkema, Utrecht & Antwerp. 1159 pp.

Stephenson SA, Hatfield J, Rusu AG, Maclean DJ, Manners JM. 2000. CgDN3: an essential pathogenicity gene of *Colletotrichum gloeosporioides* necessary to avert a hypersensitive-like response in the host *Stylosanthes guianensis*. Molecular Plant-Microbe Interactions 13: 929-941.

Sutton BC. 1980. The Coelomycetes. Fungi Imperfecti with Pycnidia, Acervuli and Stromata. Commonwealth Mycological Institute, Kew, UK. 696 pp.

Sutton BC. 1992. The genus *Glomerella* and its anamorph *Colletotrichum*. In Bailey JA, Jeger MJ (eds) *Colletotrichum:* Biology, Pathology and Control. CAB International, Wallingford, UK pp. 1-26.

Templeton GE. 1992. Use of *Colletotrichum* strains as mycoherbicides. In Bailey JA, Jeger MJ (eds) *Colletotrichum:* Biology, Pathology and Control. CAB International, Wallingford, UK pp. 358-380.

Thompson JD, Higgens DG, Gibson TJ. 1994. Clustal W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position specific gap penalties and weight matrix choice. Nucleic Acids Research 22: 4673-4680.

Timmer LW, Brown GE. 2000. Biology and control of anthracnose diseases of citrus. In Prusky D, Freeman S, Dickman MB (eds) *Colletotrichum.* Host Specificity, Pathology, and Host-Pathogen Interaction. APS Press, St Paul, USA pp. 300-316.

Waller JM, Bridge PD, Black R, Hakiza G. 1993. Characterization of the coffee berry disease pathogen, *Colletotrichum kahawae* sp. nov. Mycological Research 97: 989-994.

Waller JM, Bridge PD. 2000. Recent advantages in understanding *Colletotrichum* diseases of some tropical perennial crops. In Prusky D, Freeman S, Dickman MB (eds) *Colletotrichum.* Host Specificity, Pathology, and Host-Pathogen Interaction. APS Press, St Paul, USA pp. 337-345.

Watson AK, Gressel J, Sharon A, Dinoor A. 2000. *Colletotrichum* strains for weed control. In Prusky D, Freeman S, Dickman MB (eds) *Colletotrichum.* Host Specificity, Pathology, and Host-Pathogen Interaction. APS Press, St Paul, USA pp. 245-265.

Weidemann GJ, TeBeest DO, Cartwright RD. 1988. Host specificity of *Colletotrichum gloeosporioides* f.sp. *aeschynomenes* and *C. truncatum* in the *Leguminosae*. Phytopathology 78: 986-990.

Xiao CL, MacKenzie SJ, Legard DE. 2004. Genetic and pathogenic analyses of *Colletotrichum gloeosporioides* isolates from strawberry and noncultivated hosts. Phytopathology 94: 446-453.

Yakoby N, Beno-Moualem D, Kobiler I., Prusky D. 2002. The analysis of fruit protection mechanisms provided by reduced-pathogenicity mutants of *Colletotrichum gloeosporioides* obtained by restriction enzyme mediated integration. Phytopathology 92: 1196-1201.

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Austro-American lignolytic polypores (*Agaricomycetes*) — new records for Southern Brazil

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Abstract — Following a continuous survey of lignolytic basidiomycetes in Santa Catarina State, Brazil, ten previously unrecorded species of polypores were collected in the State Park of Serra do Tabuleiro, namely *Ceriporia tarda, Echinochaete brachypora, Fuscoporia contigua, F. ferruginosa, Irpex lacteus, Oligoporus subcaesius, Oxyporus latemarginatus, Perenniporia ochroleuca, Phellinus bambusinus, P. robustus.* Four taxa — *F. contigua, F. ferruginosa, P. bambusinus,* and *P. robustus* — also represent first records for Rio Grande do Sul State (Southern Brazil). The new combination *Oligoporus caesioflavus* is proposed.

Key words — *Hymenochaetales*, mycodiversity, *Polyporales*, wood rot

Introduction

A knowledge of the biodiversity of organisms is important, but particularly so for fungi. We know relatively little about mycodiversity, as noted by Hawksworth (2004), who reported that only 7% of a conservatively projected total of 1.5 million fungal species have been described to date.

In tropical and subtropical zones, all fungal groups remain relatively understudied. This includes wood-inhabiting fungi (Groposo & Loguercio-Leite 2005), despite their enormous importance in the carbon cycle (including their renowned ability to degrade wood and thus create gaps to allow for enhanced forest development).

The present study is part of an on-going taxonomic and biogeographical survey of wood-inhabiting fungi in Southern Brazil, especially in the Atlantic Rain Forest region (Morellato & Haddad 2000). Additional collections from the Parque Estadual da Serra do Tabuleiro (27° 42’ 09”–28° 34’ 09” S lat, 48° 57’ 23”–48° 43’ 09” W long), yielded several previously unrecorded polypore species that are briefly described below.

The survey yielded taxa with cosmopolitan and pantropical geographical distribution.

It should be noted that the *Phellinus* (s.l.) specimens examined from Herbarium ICN were collected by Coelho in Rio Grande do Sul State. Although the collector described them in his thesis (Coelho 1994), his descriptions were not formally published and so are reported here as first records for Rio Grande do Sul.

Material and methods

Periodical fungal collections were conducted between March 2004 and May 2005. Basidiomata were studied through observing both macroscopic (e.g., size, colour, number of pores/mm, length of tubes) and microscopic morphological characters (presence/absence of structures, size).

Measurements were made from slide preparations stained with 1% aqueous phloxine (plus 1% and/or 5% KOH) and Melzer's reagent (Ryvarden 1991, Singer 1975). Specimens were identified to species using specialized bibliographies and comparing collections with FLOR, BAFC, SP, HFC, ICN Herbaria (Holmgren et al. 1990). Vouchers were deposited after examination in FLOR Herbarium. Taxonomic arrangement follows Kirk et al. (2001).

Hymenochaetales Oberw.

Hymenochaetaceae Imazeki & Toki

Fuscoporia contigua (Pers.) G. Cunn.,
Bull N. Z. Dept. Sci. Ind. Res. Pl. Dis. Div. 73: 4, 1948.

Description in Gilbertson & Ryvarden (1997: 556).

Comments — The specimens present large pores (2–3/mm), both hymenial and tramal setae, respectively ((40–)45–70(–75) × 5.0–7.0 µm) and (75–160 × 6.5–10 µm), and hyaline oblong-ellipsoid basidiospores (5.0–7.5 × 3.0–3.5 µm) and those characteristics are helpful for identification (Ryvarden 2004). However, there are some discrepancies between our observations and literature data. For instance, our collections agree fairly well with Gilbertson & Ryvarden (1987), who recorded spores 5–7 × 3–3.5 µm, 2–3 pores/mm, hymenial setae ((35–)40–60(–65) × 6–10 µm) and tramal setae (40–120 × 5–12 µm). Cunningham (1965) noted smaller spores (3.5–5.5 × 3–3.5 µm) and longer hymenial setae (56–140 × 8–16 µm). Larsen & Cobb-Poulle (1990: 55–56) compare different authors' data for this species.

Distribution — Pantropical (Núñez & Ryvarden 2000); in Brazil, in Alagoas, Paraíba, Pernambuco (Gibertoni et al. 2004), Bahia (Góes-Neto 1999), Rio Grande do Sul and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Imaruí**. col. Michels & Marcon-Baltazar *394*. 20.I.2005 (*FLOR*).

Additional material — **BRAZIL. Rio Grande do Sul: Santa Maria**. Caturrita. S. Aldorindo. col. Gilberto Coelho *20-3*, *40-3*. 07/IV/1993 (*ICN 97696, 97697*).

Fuscoporia ferruginosa (Schrad.) Murrill, N. Am. Fl. 9: 5, 1907.

Description in Larsen & Cobb-Poulle (1990: 65).

Comments — The specimens have small pores (5–6/mm), oblong-ellipsoid basidiospores (4.0–7.5 × 3.0–4.0 μm), and both hymenial and tramal setae, respectively ((20–)25–50 × 5–8 μm) and (60–150 × 7.0–12 μm); this agrees with Gilbertson & Ryvarden (1987). Larsen & Cobb-Poulle (1990) noted the variation of authors' data (5–9 pores/mm, spores (4–)5–7 × (2.7–)3–3.5(–4) μm, hymenial setae (20–)25–40(–65) × 6–8 μm). *Fuscoporia ferruginosa* presents hymenial and tramal setae as in *F. contigua*, but differs by the sizes of pores and hymenial setae.

Distribution — Cosmopolitan; in Brazil, from Pernambuco, Rio Grande do Norte (Gibertoni et al. 2004), Rio Grande do Sul and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Paulo Lopes**. Albardão. col. Michels, Esber & Marcon-Baltazar *087*, *093*. 04.IX.2004 (*FLOR*).

Additional material — **BRAZIL. Rio Grande do Sul: Santa Maria**. Caturrita. S. Aldorindo. col. Gilberto Coelho *50-4*, 13.IX.1993 (*ICN 27718*); ibid, ipse *40-9*. 07.IV.1993 (*ICN 27714*).

Phellinus bambusinus (Pat.) Pat., Essai Taxon. 97, 1900.

Description in Ryvarden (1983: 6).

Comments — The specimen, collected on *Bambusa*, has effuse-reflexed basidiomata, with a black line in the context, subglobose to globose basidiospores (4.0–5.5 × (3.5–)4.0–4.5 μm), ventricose cystidioles (10–20 × 4.0–6.0 μm), and rare setae (12–23 × 6.0–10 μm). These data agree with the description made by Ryvarden (1983) and they are useful for identification. Rare globose chlamydospores are observed but they are slightly smaller (6–7.5 × 5–6 μm) than those reported by Ryvarden (1983) as conidiospores. Specimen 182 is very similar to other specimens (ICN 97690, 97691), except in having smaller basidiomata. Ryvarden (1983) notes that pore size, presence of chlamydospores, substrate, and larger basidiospores separate this species from *P. pectinatus* (Klotzsch) Quél. and *P. pullus* (Mont. & Berk.) Ryvarden.

Distribution — Not determined; in Brazil, Rio Grande do Sul and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Paulo Lopes**. Laranjal. Michels & Esber *182*, 27.XI.2004 (*FLOR*).

Additional material — **BRAZIL. Rio Grande do Sul: Santa Maria.** Itaara. Parque do Pinhal. col. Coelho *38-1.* 07.IX.1992 (*ICN 97690*); ibid, *38-2.* 06.IV.1993 (*ICN 97691*).

Phellinus robustus (P. Karst.) Bourdot & Galzin,
Bull. Soc. Mycol. France, 41: 188, 1925.

Description in Larsen & Cobb-Poulle (1990: 122).

Comments — The pileate basidiomata, ventricose cystidioles, and apiculate, dextrinoid, globose to subglobose, and thick walled basidiospores (5.0–6.5(–7.0) × 4.0–5.5(–6.0) µm) are characteristic. Hymenial setae are sometimes reported for this species but were missing in our collections. *Phellinus apiahynus* (Speg.) Rajchenb. & J.E. Wright. is similar but has smaller basidiospores (5–6 × 4.5–5.0 µm, fide Ryvarden 2004). The size of basidiomata is also critical in distinguishing these two species; then *P. apiahynus* always has smaller basidiomata measuring 1.5–5.5 × 4.0 × 0.9–2.2 cm (Loguercio-Leite & Wright 1995) or 5.0 × 3.0 × 1.0 cm (Ryvarden 2004, Wright & Blumenfeld 1984). Many authors, as Fiasson & Niemelä (1984), Dai (1999), Fischer & Wagner (2002), and Decock et al. (2007) place this taxon in *Fomitiporia* Murrill (Murrill 1907), as *Fomitiporia robusta* (P. Karst.) Fiasson & Niemelä.

Distribution — cosmopolitan; in Brazil, from São Paulo (Bononi 1979), Rio Grande do Sul and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: São Martinho.** Vargem do Cedro. Michels & Marcon-Baltazar *342.* 19.I.2005 (*FLOR*).

Additional material — **BRAZIL. Rio Grande do Sul: Santa Maria.** Camobi – próximo a Base Aérea. col. Coelho *30-2.* 09.IX.92 (*ICN 97787*); ibid, **São Paulo: Cananéia.** Ilha do Cardoso. Pereninha. col. V. L. Penteado. 20.X.1981 (*SP 141392*).

Polyporales Gäum.

Hapalopilaceae Jülich

Ceriporia tarda (Berk.) Ginns, Mycotaxon 21: 326, 1984.

Description in Gilbertson & Ryvarden (1986: 184).

Comments — The specimens studied are similar to *Antrodia porothelioides* (Berk. & M.A.Curtis ex Cooke) Ryvarden as pointed by Lowe (1966), which differs by larger basidiospores (5–6.5 × 2.5–3.5 µm) and type of wood rot. *Ceriporia viridans* (Berk. & Broome) Donk has similar basidiospores, but the characteristically slender hyphae and more uniform pinkish-brown poroid surface of *Ceriporia tarda* helps identify it in the field (Gilbertson & Ryvarden 1986).

Distribution — Pantropical; in Brazil, Paraná (Ryvarden & Meijer 2002) and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Águas Mornas**. col. Michels *346*. 18.II.2005 (*FLOR*).

Additional material — **BRAZIL. Paraná: Paranaguá. Ilha do Mel**. col. Meijer PAa (*HFC1239*).

Polyporaceae Fr. ex Corda

Echinochaete brachypora (Mont.) Ryvarden,
Bull. Jard. Bot. Nat. Belg. 48 (1–2): 101. 1978.

Description in Welden & Ovebro (1989: 602).

Comments — *E. brachypora* produces abundant, spinulose, heavily pigmented setoid elements (≤100 µm) in the hymenium, which are lacking or scattered in the pilear tomentum, as pointed previously by Welden & Ovebro (1989) and Núñez & Ryvarden (1995). In our collection, basidiospores are cylindrical, and slightly smaller (8.5–12 × 3.5–4.5 µm) than those (9.5–13 × 3.5–5.5 µm) reported by Ryvarden & Johansen (1980).

Distribution — Pantropical; in Brazil, recorded to Alagoas, Paraíba (Gibertoni et al. 2004), Bahia (Góes-Neto 1999), Paraná (Ryvarden & Meijer 2002), Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Águas Mornas**. col. Michels & Marcon-Baltazar *274*. 18.I.2005 (*FLOR*).

Additional material — **BRAZIL. Paraná: Foz do Iguaçu**. Parque Nacional do Iguaçu. col. Meijer. 29.XII.1992 (*HFC 2379*).

Oligoporus subcaesius (A. David) Ryvarden & Gilb., Syn.Fung.7: 435, 1994.

Description in Ryvarden & Gilbertson (1994: 435).

Comments — Our specimens show smaller pores (4–6/mm) and allantoid basidiospores (4–5 × 0.8–1.5 µm) than *O. caesius* (BAFC 30599) and are more similar to *O. subcaesius* (HFC 3761). Ryvarden (1983) found *Tyromyces caesioflavus*, *Oligoporus caesius* (Schrad.) Gilb. & Ryvarden, and *Oligoporus subcaesius* morphologically very similar (see Table 1).

Distribution — cosmopolitan; in Brazil, from Paraná (Ryvarden & Meijer 2002) and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz**. col. Michels, Esber, Groposo & Marcon-Baltazar *452, 460*. 20.III.2005 (*FLOR*)

Additional material — **BRAZIL. Paraná: Colombo**. Centro Nacional de Pesquisa de Florestas – Embrapa Florestas. col. Meijer & Amazonas. 17.IV.2000 (*HFC 3761*).

Oligoporus caesius. **ARGENTINA. Buenos Aires: Isla de Martin Garcia**. col. Rajchenberg & Wright *3866*. 09.I.86 (*BAFC 30599*).

Oligoporus and *Tyromyces* are morphologically similar, but produce different types of rot, brown and white respectively. We propose the following new

Table 1. Bibliographic comparison among similar species.

Character / sp	*O. caesius*	*O. subcaesius*	*O. caesioflavus*
Pores/mm Colour	3–6 whitish to bluish	4–5 [2] white to pale grey	[3] 8–10 or [4] 7–9 bluish
Pilear surface	pubescent	pubescent	glabescent
Gloeoplerous hyphae	always	absent	absent
Spores, allantoid	[2] 4.5–6 × 1.5–2 µm [1] 5.5–7.5 × 1–2 µm weakly amyloid	[2] 4–5 x 1–1.2 µm slightly amyloid in fresh specimens	[3] 3–4.5 × 1–2 µm Melzer´s minus [4] 3–4.5 × 1–1.5 µm non-amyloid
Rot	brown	brown [2]	brown [3]
GH gelatinized	yes	ND	ND

Legend: [1] Ryvarden & Gilbertson (1987); [2] Ryvarden & Gilbertson (1994); [3] Carranza (1982); [4] Ryvarden (1983). GN = generative hyphae, ND = no data

combination based on Carranza´s statement (1982: 406–407) that *T. caesioflavus* is associated with a brown rot:

Oligoporus caesioflavus (Pat.) Baltazar, Michels & C.L.Leite, **comb. nov.**

MycoBank MB 511435

Basionym: *Polyporus caesioflavus* Pat. Bull. Soc. Mycol. France, 8: 114, 1892.

≡ *Tyromyces caesioflavus* (Pat.) J. Carranza, Mycotaxon 15: 405, 1982.

Perenniporia ochroleuca (Berk.) Ryvarden, Norw. J. Bot. 19 (3–4): 233, 1972.

Description in Ryvarden & Gilbertson (1994: 459).

Comments — Ryvarden & Gilbertson (1994) and Cunningham (1965) characterize *P. ochroleuca* as producing small, ungulate basidiomata with usually ochraceous pileus surfaces and truncate, strongly dextrinoid basidiospores (12–16 × 7.0–10 µm). Smaller pores and basidiospores and ultimately, grayish black pileus separate the very similar *Perenniporia ohiensis* (Berk.) Ryvarden from *P. ochroleuca*. Previously, Corner (1989) considered *Perenniporia ohiensis* a synonym of *Truncospora ochroleuca* (Berk.) Pilát (≡*Perenniporia ochroleuca).*

Distribution — Cosmopolitan; for Brazil, recorded from Bahia (Góes-Neto 1999), São Paulo (Gerber et al. 1999), and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Palhoça.** col. Michels, Klier & Marcon-Baltazar *571*. 16.V.2005 (*FLOR*).

Additional material — **BRAZIL. Santa Catarina: Florianópolis.** Rio Tavares. col. Loguercio-Leite & Furlani *48B*. 06.I.88 (*FLOR 10513*).

Steccherinaceae Parmasto

Irpex lacteus (Fr.) Fr., Elench. Fung. 1: 145, 1828.

Description in Gilbertson & Ryvarden (1986:404).

Comments — The species showed a hydnoid hymenophore, simple-septate hyphae (2.5–5 µm), apical incrusted cystidia (30–70 × 7.0–9.0 µm) and oblong to cylindrical, slightly curved basidiospores (4.5–6.0 × 2.2–3.0 µm) good diagnostic characters according to Silveira & Guerrero (1991). Gilbertson & Ryvarden (1986) report larger cystidia (50–110 × 5–10 µm) and slightly larger basidiospores (5–7 × 2–3 µm). It is interesting to note that some species of *Steccherinum* show similar hymenophore and cystidia but have fibulate generative hyphae (Ryvarden & Gilbertson 1993).

Distribution — Cosmopolitan; in Brazil, from Paraná (Ryvarden & Meijer 2002), Pernambuco (Gibertoni et al. 2004), Rio Grande do Sul (Silveira & Guerrero 1991), São Paulo (Gugliotta & Capelari 1995) and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: São Bonifácio**. col. Michels, Santos & Tortato *218*. 17.XII.2004 (*FLOR*)

Additional material — **BRAZIL. São Paulo: Cananéia**. Ilha do Cardoso. Restinga em Maruja. col. Bononi & Yano. 20.X.1981 (*SP 157606*). ibid, **Paraná: Tuarapuava**. Segredo. col. Meijer. 14.V.1992 (*HFC 2267*).

Schizoporaceae Jülich

Oxyporus latemarginatus (Durieu & Mont.) Donk,. Persoonia 4: 342, 1966.

Description in Gilbertson & Ryvarden (1987: 494).

Comments — The species is recognized by its oblong-ellipsoid basidiospores (4–7 × 2.5–3.0(–3.5) µm), as well as apically incrusted ventricose cystidia (14–25 × 4–6.5 µm). Cystidia can be difficult to find in some specimens, which could be easily confused with the similar *Ceriporia xylostromatoides* (Berk.) Ryvarden. The latter also has smaller pores and globose basidiospores (Ryvarden & Johansen 1980).

Distribution — Cosmopolitan; in Brazil, from Bahia (Góes-Neto 1999), Paraná (Ryvarden & Meijer 2002) and Santa Catarina.

Voucher material — **BRAZIL. Santa Catarina: Santo Amaro da Imperatriz**. Morro das Três Voltas. col. Michels, Esber, Groposo & Marcon-Baltazar *496*. 20.III.2005 (*FLOR*)

Additional material — **ARGENTINA. Misiones**. C. do Iguaçu. col. Rajchenberg *M-3504*. 04.III.1982 (*BAFC 28242*). **ARGENTINA. San Isidro**. col. Wright. 12.X.1968 (*BAFC 28069*). **ARGENTINA. Entre Rios: Gualeguaychú**. Pto. Unzué. col. Deschamps *ER-2610*. 24.VIII.1982 (*BAFC 28074*). **BRAZIL. Santa Catarina : Florianópolis**. Ratones. col. Loguercio-Leite & Furlani *386*. 26.VII.1995 (*FLOR 10704*).

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Literature

Bononi VL. 1979. Basidiomicetos do Parque Estadual da Ilha do Cardoso: II. *Hymenochaetaceae*. Rickia 8: 85-99.

Carranza J. 1982. Polypores new to Costa Rica. Mycotaxon 15: 405-408.

Coelho G. 1994. Himenoquetáceaes com poros (*Basidiomycetes*) do limite sul da Serra Geral em Santa Maria, RS. Master Dissertation in Botany. Universidade Federal do Rio Grande do Sul: Porto Alegre (Brazil). 112 pp.

Corner EJH. 1989. Ad Polyporaceas V. Beihefte Zur Nova Hedwigia 96: 1-218.

Cunningham GH. 1965. *Polyporaceae* of New Zealand. N. Z. Dep. Sci. & Ind. Res. Bull. 65: 1-304.

Dai Y-C. 1999. *Phellinus* sensu lato (Aphyllophorales, Hymenochaetaceae) in East Asia. Acta Bot Fennica 166:1–115.

Decock, C, Herrera-Figueroa, S, Robledo G, Castillo G. 2007. *Fomitiporia punctata* (Basidiomycota, Hymenochaetales) and its presumed taxonomic synonyms in America: taxonomy and phylogeny of some species from tropical/subtropical areas. Mycologia 99(5): 732-752.

Fiasson JL, Niemelä T. 1984. The *Hymenochaetales*: a revision of the European poroid taxa. Karstenia 24: 14-28.

Fischer T, Wagner M. 2002.Proceedings towards a natural classification of the worldwide taxa *Phellinus* s.l. and *Inonotus* s.l., and phylogenetics relationships of allied genera. Mycologia 94(6): 998-1016.

Gerber AL, Neves MA, Loguercio-Leite C. 1999. Some species of *Perenniporia* Murrill (*Poriales, Basidiomycotina*) from Southern Brazil. Revista Brasileira de Botânica 22(2): 185-193.

Gibertoni TB, Ryvarden L, Cavalcanti MAQ. 2004. Poroid fungi (*Basidiomycota*) of the Atlantic rain forest in Norther Brazil. Synopsis Fungorum 18: 33-43.

Gilbertson RL, Ryvarden L. 1986. North American Polypores. Volume 1. Fungiflora: Oslo (Norway). p. 1-433.

Gilbertson RL, Ryvarden L. 1987. North American Polypores. Volume 2. Fungiflora: Oslo (Norway). p. 434-885.

Góes-Neto A. 1999. Polypore diversity in the State of Bahia, Brazil: a historical review. Mycotaxon 72: 43-56.

Groposo C, Loguercio-Leite C. 2005. Contribution to the lignocellulolytic fungi (*Basidiomycetes*) of the Atlantic Rain Forest in Southern Brazil. Mycotaxon 92: 103-106.

Gugliotta AM, Capelari M. 1995. *Polyporaceae* from Ilha do Cardoso, SP, Brazil. Mycotaxon 56: 107-113.

Hawksworth DL. 2004. Fungal diversity and its implications for genetic resource collections. Studies in Mycology 50: 9-18.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum: Part I: Herbaria of the World. 86th ed. Bronx, New York Botanical Garden.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9thed, CAB International.

Larsen MJ, Cobb-Poulle LA. 1990. *Phellinus* (*Hymenochaetaceae*): a Survey of the World Taxa. Synopsis Fungorum 3: 1-206.

Loguercio-Leite C, Wright JE. 1995. The Genus *Phellinus* (*Hymenochaetaceae*) on the Island of Santa Catarina, Brazil. Mycotaxon 54: 361-388.

Lowe JL. 1957. *Polyporaceae* of North America – the genus *Fomes*. State University College of Forestry at Syracuse University of Technology 80: 1-97.

Lowe JL. 1966. *Polyporaceae* of North America – the genus *Poria*. State University College of Forestry at Syracuse University of Technology 90: 1-183.

Morellato LPC, Haddad CFB. 2000. Introduction: the Brazilian Atlantic Forest. Biotropica 32(4b): 786-792.

Murrill WA. 1907. (*Agaricales*) *Polyporaceae* (pars). North American Flora 9(1): 1-72.

Núñez M, Ryvarden L. 1995. *Polyporus* (*Basidiomycotina*) and related genera. Synopsis Fungorum 10: 1-85.

Núñez M, Ryvarden L. 2000. East Asian polypores. Volume 1. Synopsis Fungorum 13: 1-168.

Rajchenberg M. 2006. Los Políporos (*Basidiomycetes*) de los Bosques Andino Patagónicos de Argentina. Biblioteca Mycologica: Berlin – Stuttgart (Germany). 300 pp.

Ryvarden L. 1983. Type studies in the *Polyporaceae* 14. Species described by N. Patouillard, either alone or with other mycologists. Occasional Pappers of Farlow Herbarium 18: 1-39.

Ryvarden L. 1991. Genera of Polypores – Nomenclature and taxonomy. Synopsis Fungorum 5: 1-363.

Ryvarden L. 2004. Neotropical polypores Part 1. Synopsis Fungorum 19: 1-229.

Ryvarden L, Gilbertson RL. 1993. European polypores. Part 1. Synopsis Fungorum 6: 1-387.

Ryvarden L, Gilbertson RL. 1994. European polypores. Part 2. Synopsis Fungorum 7: 395-743.

Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora: Oslo (Norway). 630 pp.

Ryvarden L, Meijer AAR. 2002. Studies in neotropical polypores 14 New species from the state of Paraná, Brazil. Synopsis Fungorum 15: 34-69.

Silveira RMB, Guerrero RT. 1991. *Aphyllophorales* poliporóides (*Basidiomycetes*) do Parque Nacional de Aparados da Serra, Rio Grande do Sul. Boletim do Instituto de Biociências 48: 1-127.

Singer R. The *Agaricales* in Modern Taxonomy. 1975. 3rd ed. J. Cramer: Vaduz (Liechtenstein). 912 pp.

Welden AL, Ovebro CL. 1989. Notes on tropical and warm temperate *Basidiomycetes*. Mycotaxon 34(2): 601-614.

Wright JE, Blumenfeld SN. 1984. New South American species of *Phellinus* (*Hymenochaetaceae*). Mycotaxon 21: 413-425.

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Porodisculus orientalis sp. nov. (*Schizophyllaceae, Agaricales*) from East Asia

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Abstract — Specimens of *Porodisculus* are easily recognized by their brown, tiny pendant fruiting bodies with a poroid hymenophore. However, Asian specimens are slightly different from American specimens in the size of the pores and basidiospores. Phylogenetic approaches were used to determine whether two specimens from South America and four specimens from East Asia were cryptic species. The results strongly suggest that Asian and American collections represent two different species. Therefore, Asian *Porodisculus* is proposed as a new species, *Porodisculus orientalis*.

Key words — *Basidiomycota*, taxonomy, phylogeny, ITS, RPB2

Introduction

The genus *Porodisculus*, which was erected by Murrill (1907), contains only *P. pendulus* (Schwein.), one of the smallest polypore species. *Porodisculus* means "little poroid disk" and *pendulus* means "hanging down," and the common name of this saprobic fungus is "pendulous-disc polypore." It is solitary but occurs in large numbers on fresh dead deciduous branches (Murrill 1903, Ginns 1997). Until recently, this species was classified in the artificial family *Polyporaceae*. However, phylogenetic relationships established by analyses of rDNA sequences suggest that this species belongs to the schizophylloid group of the euagarics clade with *Schizophyllum* (Bodensteiner et al. 2004, Lee 2006).

Morphologically, *P. pendulus* is easily recognized by its brown, tiny pendant fruiting bodies. It is a pantropical species that has been reported from Africa, Asia, and the southern hemisphere (Ryvarden & Johansen 1980, Gilbertson & Ryvarden 1987, Imazeki et al. 1995, Buchanan & Ryvarden 2000). However, the fungus from East Asia described here is slightly different from American

TABLE 1. *Porodisculus* specimens used in this study.

SPECIES	VOUCHER NO.	LOCALITY	GENBANK ACC. NO.	
			ITS	RPB2
Porodisculus orientalis	SNU-m 030828-101[a]	Korea	EU423186	EU423191
	SNU-m 040513-02	Korea	EU423185	EU423193
	SNU-m 030920-16	Korea	EU423187	EU423192
	HUO12154[b]	Japan	EU423188	EU423195
Porodisculus pendulus	HUO12151	Brazil	EU423189	EU423194
	HUO12158	Columbia	EU423190	EU423196

[a] SNU, Seoul National University Herbarium, Seoul, Korea, Holotype

[b] HUO, University of Oslo Mycological Herbarium, OSLO, Norway

specimens in the size of the pores and basidiospores. Therefore, we reasoned that more than one phylogenetic species may be recognized in the morphological species *P. pendulus*. Phylogenetic species concepts based on molecular (DNA) characters are now being used to delimit species in morphological fungal species complexes. To determine phylogenetic species boundaries in *Porodisculus*, phylogenies were reconstructed based on two independent genes from six specimens of *Porodisculus* from Asia and South America.

Materials and methods

Specimens

Six specimens of *Porodisculus* were examined (Table 1). Among them, three specimens were received from the University of Oslo Mycological Herbarium (HUO). Cultures were grown at 24°C on malt extract agar in a biological oxygen demand incubator.

Microscopic observations

Specimens were observed under an optical microscope at magnifications of 400× and 1000×. Measurements and drawings were made from slide preparations mounted in 3% (w/v) potassium hydroxide and stained with 1% (w/v) phloxine in water (Largent et al. 1977).

Molecular approaches

Total DNA was extracted from dried specimens and cultured mycelium using a genomic DNA extraction kit (Bioneer, Korea). Before DNA extraction, dried specimens were washed five times with sterile water to remove contaminants. Extracted DNAs were stored at –20°C until required.

PCR amplification was carried out in a 20 μl reaction mixture using PCR premix (Genenmed, Korea) and primer sets ITS5 (5'-GGA AGT AAA AGT

CGT AAC AAG G-3')and ITS4 (5'-TCC TCC GCT TAT TGA TAT GC-3') (White et al. 1990) for the internal transcribed spacer (ITS) rDNA region and primers RPB2-6F1 (5'-CAC AAY CAN CAY TGG GGW ATG GT-3') and RPB2-7R1 (5'-ATR TTG GCC ATN GTR TCC AT-3') (Liu et al. 1999) for six to seven regions of RNA polymerase subunit II (RPB2). Amplifications were performed in a PTC-100 Programmable Thermal Controller (MJ Research, USA). Amplified products were examined with agarose gel electrophoresis using a 1 kb DNA marker (Invitrogen, USA), and purified with a PCR purification kit (Genenmed, Korea). Sequences of the ITS rDNA regions were determined by overlapping sequencing reactions on complementary DNA strands with primers ITS5 and ITS4, and those of the partial RPB2 genes were determined with primers RPB2-6F1 and RPB2-7R1, using an ABI 3730XL automated sequencer (Applied Biosystems, USA).

The sequences generated from examined materials were proofread, edited, and aligned with sequences retrieved from GenBank using the jPHYDIT program (Jeon et al. 2005). Phylogenetic trees were inferred from the datasets using neighbor-joining (NJ), maximum parsimony (MP), and maximum likelihood (ML) methods in PAUP 4.0b10 (Swofford 2002).

Results and discussion

Porodisculus has been considered to be a monotypic genus. However, we found that Korean specimens were slightly different from the description of American *P. pendulus* (Gilbertson & Ryvarden 1987) in terms of the size of pores and basidiospores. After adding three *Porodisculus* specimens from Japan and South America (Brazil and Colombia), six specimens were compared using morphological and phylogenetic analyses. *Porodisculus pendulus* was originally described from North America (Murrill 1907, Ginns 1997). To compare the new specimens to the North American taxa in the phylogenetic analysis, the ITS sequence of a specimen from the USA (AY572009) was included.

Asian specimens differed from American specimens morphologically. The pores of Asian specimens (named *P. orientalis* below) were larger (7–8 per mm) compared to the smaller size (8–10 per mm) of the American *P. pendulus*. Basidiospores of *P. orientalis* were also larger — (4.5–)5.0–5.5 × 1.0–1.2 µm (n=10) compared to 3.5–4.5 × 0.8–1.0 µm (n=10) for *P. pendulus*. This agrees with descriptions of North American *Porodisculus* (Overholts 1933, 1953; Lowe 1942; Gilbertson & Ryvarden 1987), where basidiospore size was reported to be 3.0–4.5 × 1 µm. However, Ginns (1997) reported a larger basidiospore size [(4.0–)4.8–6.0(–6.8) × 1.2–1.4(–1.6) µm] for his North American specimens. Unfortunately, we did not examine these collections. It is necessary to examine more collections from other localities to determine whether spore size is a key character to differentiate the two *Porodisculus* species.

```
(A)
Locus                                              (ITS1-5.8S-ITS2)
site                          0000000111111111111111111111111111111111111111111111111111111111111112
                              4445699011333333344444444555555556666666777777777788888888889999999999
                              1254013089456789012345789345678901234690123456789012345678901234567890

P. orientalis SFC03092016     ACACCAAC--GGAAAAAAAGAGAGACTTTGCGGCTGGTTCGCCGCCCGCTCGCCTTTTTTCATTTTTGGA
              SFC04051302     .......A..............................................................
              SFC030828101    .......A..............................................................
              HUO12154        .......C..............................................................
   P. pendulus HUO12151       CACTT---CG-----------TGCTGGGGAGAAA.CCC--------------------------------
              HUO12158        CACTT---CG-----------TGCTGGGGAAAT.CCCC--------------------------------

Locus                                              (ITS1-5.8S-ITS2)
site                          2222222245555555555555555555566666666666666666666666666666666677777777
                              0022222550111111122222233455666777777777788888888889999999999900003366
                              4934678254345678901234785868489012345678901234567890123456789012341670

P. orientalis SFC03092016     GTTTACACCAGGGGAATATTTTCTCTTGCGGCTTTTTTGCTGTCGCTCGAAAGAGCCTCACAAACACA-A
              SFC04051302     ...........---........................................................
              SFC030828101    ...........---........................................................
              HUO12154        ...........---...................................................G...
   P. pendulus HUO12151       TGCACATTT.------------AGTCGTA-------------------------------------..AG
              HUO12158        TG.ACATTTC------------AGTCGTA-------------------------------------.G..


(B)
Locus                                   (RPB2)
site                          000001111111222222222223333333333344444455555555566
                              37789023456990112334567122333446992338892444566711
                              62843508162581468173210814679289699890923039819028

P. orientalis SFC03092016     CGCAACGCGAGCCCCGCGGTTCCTGCGTGTTCTTTACACCGCTCATATAT
              SFC04051302     ..................................................
              SFC030828101    ..................................................
              HUO12154        ..................................................
   P. pendulus HUO12151       TTATCTCTAGCTTTTATCAACTTAATACTCCTCACGTGT.ATCTG.TCGC
              HUO12158        TTATCTCTAGCTTTTATCAACTTAATACTCCTCACGTGTTATCTGCTCGC
```

FIGURE 1. Distribution of nucleotide polymorphisms among the specimens of *Porodisculus pendulus* and *P. orientalis.*

PCR amplification of ITS regions by primers ITS5 and ITS4 revealed size variations between PCR products of the two species. Total sequence lengths of the new species were longer than those of the American *P. pendulus* by about 90 bp. The sequence length of the ITS1-5.8S rDNA-ITS2 region of the new species was about 850 bp, while that of the American species was about 760 bp. There were small intraspecific variations in the ITS region of *P. pendulus* from the American continent (8–9 out of 717 positions showed nucleotide differences, denoted as "8–9/717") and in the ITS region of *P. orientalis* from Korea and Japan (1–2/860). However, the dissimilarity between the two species ranged from 5.3 to 5.5% (38–39/715). Variable sites of the ITS region are shown in FIG. 1. These results imply that multiple insertions are present in the DNA regions. All amplified products from primers RPB2-6F1 and RPB2-7R1 were about 670 bp, and sequenced DNA regions were 636 bp. There was no intraspecific variation in the RPB2 genes of *P. orientalis* from East Asia (0/636), but there was a difference of two bases between two American specimens of *P. pendulus* (2/636). However, the dissimilarity between the two species ranged from 7.6 to 7.9% (48–50/636), and variable sites of the RPB2 gene are shown in FIG. 1.

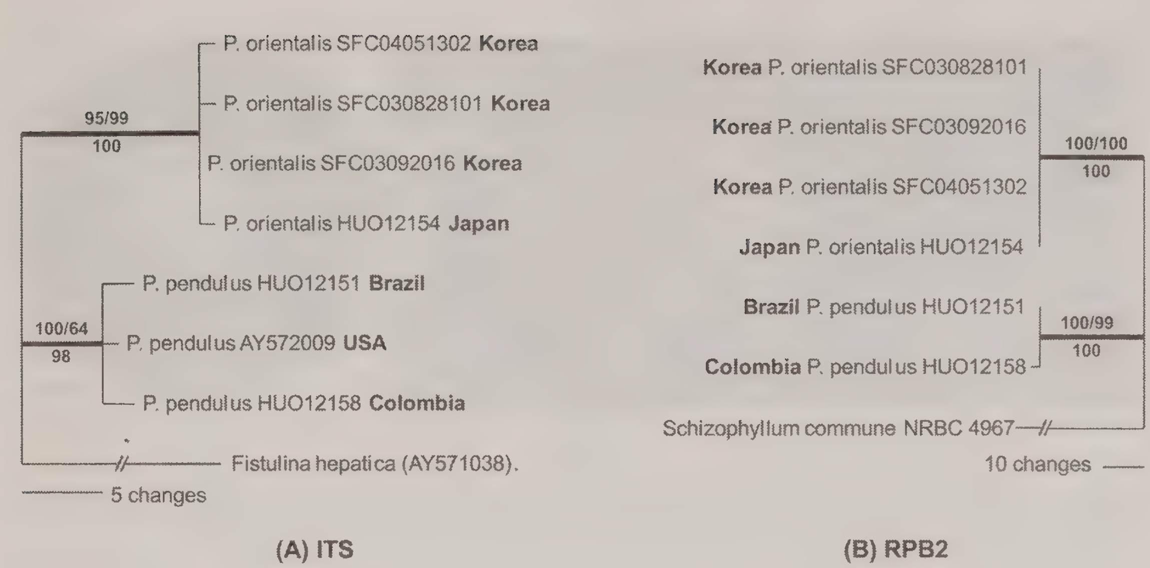
P. orientalis SFC04051302 Korea
P. orientalis SFC030828101 Korea
P. orientalis SFC03092016 Korea
P. orientalis HUO12154 Japan
95/99
100
P. pendulus HUO12151 Brazil
P. pendulus AY572009 USA
P. pendulus HUO12158 Colombia
100/64
98
Fistulina hepatica (AY571038).
5 changes
(A) ITS
Korea P. orientalis SFC030828101
Korea P. orientalis SFC03092016
Korea P. orientalis SFC04051302
Japan P. orientalis HUO12154
100/100
100
Brazil P. pendulus HUO12151
Colombia P. pendulus HUO12158
100/99
100
Schizophyllum commune NRBC 4967
10 changes
(B) RPB2

FIGURE 2. The most parsimonious tree of *Porodisculus pendulus* and *P. orientalis* based on sequence data of the ITS region (A) and RPB2 gene (B). Branches maintained in three different analyses (MP, ML and NJ analysis) were presented by bold lines. Numbers above branches that are before the slash are MP bootstrap proportions and those that are after the slash are ML bootstrap proportions. Values below branches are NJ bootstrap proportions. The ITS sequence of *Fistulina hepatica* (AY571038) and RPB2 sequence of *Schizophyllum commune* (NRBC 4967) were used as outgroup in each tree.

MP analyses based on the sequences of the ITS1-5.8S rDNA-ITS2 region yielded one most parsimonious tree (FIG. 2A; tree length = 60). The tree was rooted with the sequence of *Fistulina hepatica* (AY571038), which had the highest similarity among ITS sequences in the GenBank database. The tree showed that the new *Porodisculus* species formed a distinct clade at the 95 % confidence level, which differed from results for the *P. pendulus* clade. Two independent lineages that were supported by high bootstrap values in the parsimony analysis were recovered in the NJ and ML analyses. Branches supported in the three different analyses are represented by bold lines in the tree. MP analyses based on the sequences of the RPB2 gene yielded one most parsimonious tree (FIG. 2B; tree length = 222). The tree was rooted with the sequence of *Schizophyllum commune* (NRBC 4967), which showed the highest similarity among RPB2 sequences in the GenBank database. All three phylogenetic analyses of the RPB2 gene also partitioned the specimens into two strongly supported phylogenetic species: one species from Asia, the other from America.

The sequence dissimilarities of the ITS region and RPB2 gene between the two species were greater than previous reports for other basidiomycetes (Anderson & Stasovski 1992, Lim & Jung 2003). Phylogenetic analyses of ITS and RPB2 sequence data indicated that these two species formed unique lineages that were distinct from the lineages found on other continents. The results of the sequence analysis, coupled with morphological characteristics,

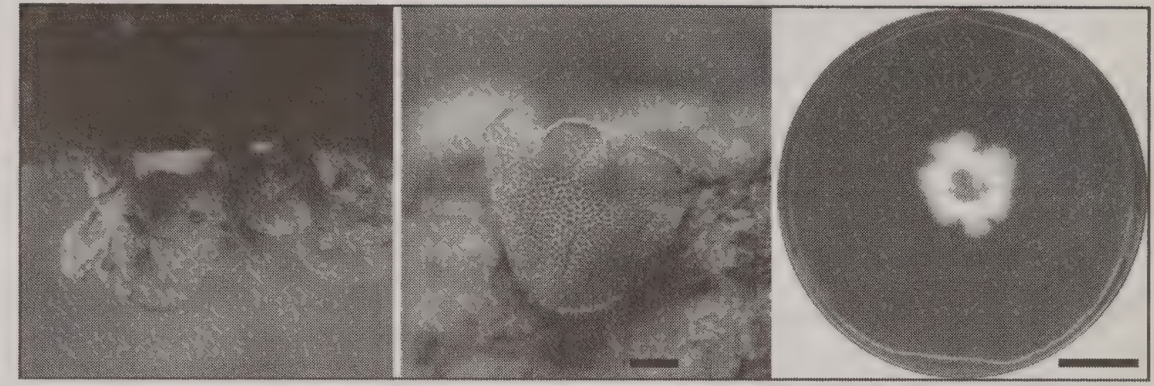

FIGURE 3. Photographs of *Porodisculus orientalis*; (A) Upper surface (bar = 1 mm), (B) Pore surface (bar = 1 mm), and (C) Culture grown on MEA in 5 days at 25 °C (bar = 2 cm)

indicated that the Asian *Porodisculus* specimens did not belong to the earlier described fungal species, *P. pendulus*. Therefore, a new species is described and named *P. orientalis*

Porodisculus orientalis J.S. Lee & H.S. Jung, **sp. nov.** FIGURE 3

MYCOBANK MB 512434

Basidiocarpus solitarius vel multiiugus, minutius, 5mm latus, pensilis; pileus, tubaeformis, sessilis, paulatim sursum ad stipes angustata, cremeo-albidus vel sub-brunneus, farinosus; margine tenuis vel curvus; stipes verticalis, centralis vel lateralis, incurvus ad basium; poris, superficies albidi-badius, teres, minutius, 7–8 per mm. Systema hypharum monomiticum; hyphae generatoriae, tenuitunicatae, 2–4 μm latae, capitis 10 μm diam., hyalinae; basidiis clavus, 9–10 × 2.5–3 μm; basidiosporae curvo-cylindricae, (4.5–)5.0–5.5 × 0.8–1.0 μm, tenuitunicatae. Holotypus in herbarium SNU; numero accessiono m-030828-108.

ETYMOLOGY : "orientalis," from its geographical distribution in East Asia

Basidiocarps solitary but often many fruiting bodies together, small, 5 mm wide, pendant; pileus tubiform, sessile, tapering toward the stipe, pale brown, farinose; margin thin, often curved inwards when dry; stipe vertical, central to lateral, bent at the attachment; pore surface pale brown; pores round, minute, 7–8 per mm. Hyphal system apparently monomitic; generative hyphae, thin-walled, 2–4 μm across, with capitate hyphal ends 10 μm across, hyaline; basidia clavate, 9–10 × 2.5–3 μm; basidiospores slightly allantoid to cylindrical, (4.5–) 5.0–5.5 × 0.8–1.0 μm, thin-walled.

COLLECTIONS EXAMINED: **KOREA**: MT. DEOGYU, Jeonbuk Province, on a branch of *Quercus*, 28 August 2003, J. S. Lee, deposited in Seoul National University Herbarium (SNU), Specimen No. SNU m-030828-101 (**Holotype**); 20 September 2003, J. S. Lee, Seoul National University Herbarium, Specimen No. SNU m-030920-16. MT. JIRI, Jeonbuk Province, 13 May 2004, J. S. Lee, Seoul National University Herbarium, Specimen No. SNU m-040513-02; **JAPAN**: Kyoto, on bark of *Quercus serrata*, 27 Oct. 1991, T. Hattou, University of Oslo Mycological Herbarium (HUO), Specimen No. 12154

Cultural characteristics: Growth rate on MEA 7–10 mm in 5 days at 25 °C. Advancing zone even, slightly appressed downy. Mat cottony to cottony-wooly, white. Aerial mycelium downy, cottony, white, hyphae 2–4 µm wide (Fig. 3).

> Culture Examined: SNU m-030828-101 isolated from the tissue of the holotype basidiocarp.

Notes — *Porodisculus orientalis* is easily recognized by its brown, tiny pendant fruiting bodies with poroid hymenophores. It is distributed in East Asia (specimens observed were from Japan and Korea). It is similar to *P. pendulus* and these two species have been considered as the same species. However, *P. orientalis* is slightly different from American specimens of *P. pendulus* in the sizes of pores and basidiospores. The pores of *P. orientalis* are slightly larger than those of *P. pendulus* (*P. orientalis*: 7–8 per mm, *P. pendulus*: 8–10 per mm). The spores of *P. orientalis* are also larger than those of *P. pendulus* (*P. orientalis*: (4.5–)5.0–5.5 × 1.0–1.2 µm, *P. pendulus*: 3.5–4.5 × 0.8–1.0 µm). In addition, in phylogenetic analyses, *P. orientalis* and *P. pendulus* represented different independent lineages.

Acknowledgments

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Literature cited

Anderson JB, Stasovski E. 1992. Molecular phylogeny of northern hemisphere species of *Armillaria*. Mycologia 84: 505-516.

Bodensteiner P, Binder M, Moncalvo J-M, Agerer R, Hibbett DS. 2004. Phylogenetic relationships of cyphelloid homobasidiomycetes. Molecular Phylogenetics and Evolution 33: 501-515.

Buchanan P, Ryvarden L. 2000. An annotated checklist of polypore and polypore-like fungi recorded from New Zealand. New Zealand Journal of Botany 38: 265-323.

Gilbertson RL, Ryvarden L. 1987. North American Polypores. Vol. II. Fungiflora. Oslo, Norway.

Ginns J. 1997. *Porodisculus pendulus*: systematics, cultural characters, and Canadian records. Canadian Journal of Botany 75: 220-227.

Imazeki R, Otani Y, Hongo T. 1995. Fungi of Japan. Yamakei Publishers, Tokyo, Japan.

Jeon YS, Chung H, Park S, Hur I, Lee JH, Chun J. 2005. jPHYDIT: a JAVA-based integrated environment for molecular phylogeny of ribosomal RNA sequences. Bioinformatics 21: 3171-3173.

Largent DL, Johnson D, Watling R. 1977. How to identify mushrooms to genus, III. Microscopic features. Mad River Press, Eureka, CA.

Lee JS. 2006. Taxonomic and Phylogenetic Studies on Korean *Aphyllophorales* based on Molecular Sequences. PhD Thesis. Seoul National University, p. 291. Seoul, Korea.

Lim YW, Jung H S. (2003) *Irpex hydnoides*, sp. nov. is new to science, based on morphological, cultural and molecular characters. Mycologia 95: 694-699.

Liu YJ, Whelen S, Hall BD. 1999. Phylogenetic relationships among ascomycetes: evidence from an RNA polymerase II subunit. Molecular Biology and Evolution 16: 1799-1808.

Lowe JL. 1942. The *Polyporaceae* of New York State. N. Y. State Coll. For. Syracuse Univ. Tech. Publ. No. 60.

Murrill WA. 1903. The *Polyporaceae* of North America, –V, The genera *Cryptoporus, Piptoporus, Scutiger* and *Porodiscus*. Bulletin of the Torrey Botanical Club 30: 423-434.

Murrill WA. 1907. *Polyporaceae*. N. Am. Flora, 9: 1-72.

Overholts LO. 1933. The *Polyporaceae* of Pennsylvania. I. The genus *Polyporus*. Pennsylvania State Coll. Agric. Exp. Sta. Bull. No. 298.

Overholts LO. 1953. The *Polyporaceae* of the United States, Alaska and Canada. University of Michigan Press, Ann Arbor. Mich.

Ryvarden L, Johansen I. 1980. A Preliminary Polypore Flora of East Africa. Fungiflora, Oslo, Norway.

Swofford DL. 2002. PAUP*4.0b Phylogenetic analysis using parsimony (* and other methods), version 4. Sinauer Associates, Sunderland, MA .

White TJ, Bruns TD, Lee SB, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In PCR Protocols: A guide to methods and application (eds. MA Innis, DH Gelfand, JJ Sninsky, TJ White), pp. 315–322. Academic Press, San Diego.

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Opegrapha viridistellata (*Roccellaceae*), a new foliicolous lichen species from the Paleotropics

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Abstract — The new foliicolous species *Opegrapha viridistellata* is described from the Paleotropics. The species is characterized by a pale greyish green thallus without black dots, partially branched apothecia covered by a thin thalline layer, predominantly 4-septate ascospores and abundant black pycnidia producing two conidial types.

Key words — Australia, Ivory Coast, Japan, New Caledonia, Papua New Guinea, Seychelles, Thailand

Introduction

For several years we have been aware of an easily recognizable, though undescribed species of *Opegrapha*, characterized by its partially branched apothecia covered by a thin thallus layer, its abundant pycnidia, and its predominantly 4-septate ascospores. Originally discovered in Papua New Guinea, the species was eventually reported from Africa (Ivory Coast: Lücking et al. 1998), the Seychelles (Seaward & Aptroot 2006), Japan (Thor et al. 2000), Australia (Lücking et al. 2001) and New Caledonia (Lücking & Kalb 2001). To avoid spreading a nomen nudum further, the species is here described formally, with accounts on its diagnostic features, its taxonomic position, and its world distribution.

The species

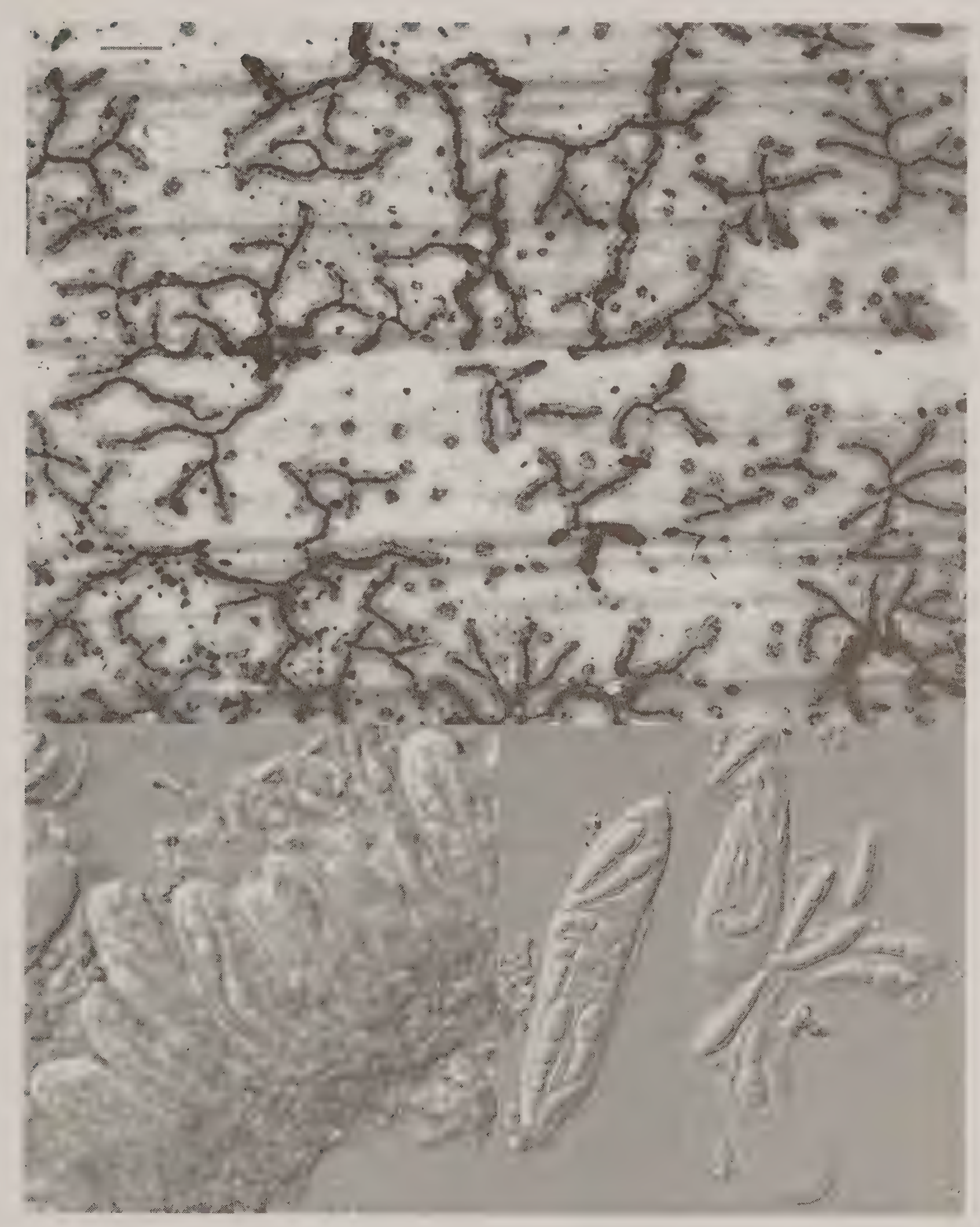
Opegrapha viridistellata Sérus., Lücking & Sparrius **sp. nov** Fig. 1-2
MycoBank MB 511475
= *Opegrapha viridistellata* Sérus., in Lücking & al., Herzogia 13: 213. 1998, nom. nud.

= *Opegrapha viridistellata* Sérus., in Thor & al., Symb. Bot. Upsal. 32(3): 49. 2000, nom. nud.
= *Opegrapha viridistellata* Sérus., in Lücking & al., Lichenologist 33: 209. 2001, nom. nud.
= *Opegrapha viridistellata* Sérus., in Lücking & Kalb, Bibl. Lichenol. 78: 260. 2001, nom. nud.
= *Opegrapha viridistellata* Sérus., in Seaward & Aptroot, J. Hattori Bot. Lab. 100: 775. 2006, nom. nud.

Species foliicola Opegrapha vegae, *similis est, sed differt in ascosporis 4-septatibus majoribusque (15-19 × 4-5 µm), et apotheciis thallo tectis.*

Thallus foliicolous, epiphyllous, very thin, yellowish green (when fresh) to greyish green, usually discontinuous (most probably because of thallus brittleness, being easily flaked off in herbarium specimens). Prothallus not visible. Photobiont: a species of *Phycopeltis*, cells angular to oblong, 7-10 × 5-6 µm, not arranged in regular, radiating rows. Ascocarps elongate, sparsely to densely branched and partially stellate, irregularly bent or undulating, up to 2.0 × 0.1-0.3 mm, black but laterally covered by thin layer of grey thalline tissue, disc visible as slit, exposed part of epihymenium to 0.05 mm wide, dark brown-black; excipulum 70-80 µm wide, of sclerotized, radiating hyphae; hypothecium hyaline to pale blackish, c. 10 µm high, I-, K/I+ pale violet; hymenium 40-45 µm high, hemiamyloid, I+ red, K/I+ blue in most areas (some patches more intensely coloured); epithecium pale brownish, K-; paraphysoids sparsely branched and anastomosing, 1-2 µm thick, apices 2-3 µm thick, colourless to pale brown; asci 8-spored, clavate, 35-40 × 15-17 µm, with an apical K/I- refringent ring; spores fusiform to almost clavate, (3-)4-septate, with second cell (when counted from distal end) somewhat enlarged, especially when young, with up to 2 µm thick epispore and rounded ends, slightly but distinctly constricted at the septum between the two most distal cells and the other three, and easily broken at that level, colourless when mature, (14-)15-19(-23) × 4-5(-7) µm. Pycnidia abundant, black, laterally covered by thallus tissue, up to 0.1 mm diam.; two types of conidia produced, sometimes within the same pycnidium: (a) microconidia bacilliform, slightly curved to crescent-shape, (2-)3-5 × 1 µm, (b) macroconidia filiform, straight, 15-17 × 1 µm.

Notes — This new species is characterized by the abundant black pycnidia, the green thallus and the partially branched and stellate apothecia covered by a thin thalline layer, in combination with the 4-septate ascospores. The central part of the thallus with ascomata is usually surrounded by thallus islets with a central pycnidium. The species is somewhat similar to *Opegrapha vegae* R. Sant., but this species has (1–)3-septate, smaller spores (8-14 × 2-3 µm) and slightly longer microconidia (4-6 × 1.5 µm) (Santesson 1952), and its apothecia are exposed and not covered by thallus tissue. Thus far, all other known foliicolous



Figs. 1–2. *Opegrapha viridistellata* (holotype). Fig. 1 (top). Ascomata and pycnidia. Bar = 1 mm. Fig. 2 (bottom, from left to right). Hymenium with mature ascospores; asci gently pressed in water, one with expelled ascospores. Bar = 20 µm.

species of *Opegrapha* have exposed, pure black and rarely branched apothecia, which make the new species easily recognizable morphologically.

Some lichenicolous species might look similar to *O. viridistellata* and are probably closely related. This applies in particular to *O. ectolechiacearum*

Matzer & R. Sant. (Matzer 1996), which has a very similar type of ascomata and ascospores; however, besides its lichenicolous growth on *Calopadia*, *Loflammia* and *Sporopodium* species, its ascospores become brownish and ornamented when old, a feature not observed in *Opegrapha viridistellata*.

The even number of four ascospore septa is somewhat unusual among lichens but can be found in other species of the *Roccellaceae*, such as *Mazosia rubropunctata* R. Sant. (Santesson 1952) and *Enterographa brezhonega* Sparrius & Aptroot (2007).

One of the earliest collections examined (Papua New Guinea, Demoulin 5952 & Smeets, LG) was published under *Opegrapha filicina* Mont. (Sérusiaux 1984); two types of conidia were described and this observation is here confirmed. Ascospores and conidia are illustrated in figs 12-13 of that paper.

DISTRIBUTION AND ECOLOGY — The species is apparently widely distributed in the Paleotropics, where it occurs at altitudes from sea level (mangroves, palms and lowland rainforest) up to 1100 m (submontane and subtropical forest). It has not been found in the Neotropics.

In Thailand, the new species grows in a species-poor association with *Porina epiphylla*, *P. rufula*, *P. virescens*, *Strigula nemathora* and *Trichothelium* sp. in secondary forest in a shaded valley with remnants of mature primary forest with *Manglietia*-trees. The leaves have been collected in the lower canopy, at 10 m height.

SPECIMENS EXAMINED — ASIA. Papua New Guinea: Madang prov., bridge over Gogol river, road from Lae about 15 km from Madang, 5°20'S 145°43'E, 30 m, evergreen rain forest, on leaves of *Arenga microcarpa*, Apr 1987, J. Lambinon 87/370 (LG—**holotype**, hb. Lücking, hb. Vezda—isotypes). Between Awar plantation and Boroi, sea-level, 4°06'S 144°48'E, foliicolous on palm tree, 1980, V. Demoulin 5952 & L. Smeets (LG). Near Bogia, mangrove island in mouth of Boroi river, 1 m, 4°04'S 144°47'E, foliicolous, July 1992, E. Sérusiaux 13207-3 (LG). Thailand: Chiang Mai prov., 10 km W of Chiang Mai, Doi Suthep-Pui Nat. Park, 18°48'N 98° 54'E, 1000-1100 m, secondary forest in valley, Oct 2002, on *Manglietia garrettii*, L.B. Sparrius 7079 (hb. Sparrius, LG, CMU). Japan: Ishigaki-jima (Yaeyama Islands, Okinawa Pref.), 13 km NNE of Ishigaki city, along trail on S slope of Mt. Omoto, summit area, Ishigaki-city administrative area, 24°25'N 124°11'E, 500-520 m, dense oldgrowth, subtropical forest, Feb 1995, on *Satakentia liukiuensis*, T. Matsumoto 2693 (HIRO, in a collection of *Porina virescens*) and G. Thor 13042 (TNS, UPS). AUSTRALIA-OCEANIA: Australia: Queensland: Eacham Shire, Souita Falls, 8 km SE of Millaa Millaa, 17°35'S, 145°40'E, tropical rainforest, Aug 1987, Henssen 31241 (hb. Henssen). New Caledonia: Province Sud: Monts Koghis-Dumbéa, 15 km of Nouméa, 22°14'S, 166°30'E, 550 m, tropical rainforest, Mar 1994, Kalb & Kalb s.n. (hb. Kalb). AFRICA. Ivory Coast: Taï National Park, 5°52'N, 7°27'W, 200 m, Sept-Oct 1992, Becker s.n. (hb. Becker). Abidjan forest of Banco, 5 km N of Abidjan, 50 m, lowland rainforest, on leaves of *Tylostemon*, Aug 1954, R. Santesson 10333c (UPS). Seychelles: Silhouette, Belle Vue, 230 m, on leaves of *Cinnamomum*, July 2000, Seaward 119A, 121A (hb. Seaward).

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Literature cited

Lücking R, Becker U, Follmann G. 1998. Foliikole Flechten aus dem Taï Nationalpark, Elfenbeinküste (Tropisches Afrika). II. Ökologie und Biogeographie. Herzogia 13: 207-228.

Lücking R, Kalb K. 2001. New Caledonia, foliicolous lichens, and island biogeography. Bibliotheca Lichenologica 78: 247-273.

Lücking R, Streimann H, Elix JA. 2001. Further records of foliicolous lichens and lichenicolous fungi from Australasia, with an updated checklist for continental Australia. Lichenologist 33: 195-201.

Santesson R 1952. Foliicolous lichens I. A revision of the taxonomy of the obligately foliicolous, lichenized fungi. Symb. Bot. Upsal. 12(1): 1-590.

Santesson R, Lücking R. 1999. Additions to the foliicolous lichen flora of the Ivory Coast and Guinea (Tropical West Africa). Nord. J. Bot. 19: 719-734.

Seaward MRD, Aptroot A. 2006. A preliminary checklist of lichens for the Seychelles Group. - Journal of the Hattori Botanical Laboratory 100: 765-781.

Sérusiaux E. 1984. New species or interesting records of foliicolous lichens. Mycotaxon 20: 283-306.

Sparrius LB, Aptroot A. 2007. A new lichenicolous *Enterographa* species from Britanny (France). Lichenologist 39: 315-317.

Thor G, Lücking R, Matsumoto T. 2000. The foliicolous lichens of Japan. Symb. Bot. Ups. 32(3): 1-72.

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Pronectria minuta, a new lichenicolous ascomycete from Poland and Russia

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Abstract — *Pronectria minuta* (*Bionectriaceae, Hypocreales*) is described as new for science. It was found in Poland and NW Russia and occurs on *Cladonia* (subgen. *Cladina*). The fungus is compared with *P. tibellii*, the only other *Pronectria* species known as occurring on *Cladonia*, as well as with some other species with small spores.

Key words — fungal diversity, lichenicolous fungi

Introduction

Cladonia Hill ex P. Browne is a large lichen genus with over 80 known species of lichenicolous fungi occurring on their thalli. A key to identify most of them was provided by Zhurbenko & Alstrup (2004), and Hansen & Alstrup (1995) provided special treatment of fungi growing on *Cladonia* subgen. *Cladina.* While collecting lichens and lichenicolous fungi during the First Workshop of Young Lichenologists in Russia (Khibiny Mountains, Kola Peninsula, August, 2000) one of the authors found a discoloured specimen of *Cladonia stellaris* that appeared to be strongly infested by an unknown species of *Pronectria.* Several years later, a second specimen of the fungus, this time growing on *C. arbuscula* s.lat., was found in Poland.

Despite the fact that the lichenicolous hypocrealean genus *Pronectria* Clements is found on variety of lichens and has a wide distribution, it is generally rarely collected. Immersed to semi-immersed, small perithecia contribute to the poor knowledge of the genus (Etayo 1998, Lowen & Diederich 1990). Although since 1990 a number of new species have been described in the genus (Etayo 1998, 2001, 2002; Kondratyuk 1996, Etayo & Diederich 1996, Lowen

1995, Lowen & Diederich 1990, Rossman et al. 1999, Zhurbenko et al. 2005), so far only one species, *P. tibellii*, has been known to inhabit *Cladonia* (Zhurbenko & Alstrup 2004). The taxon found by the authors appeared to differ from all known *Pronectria* species and is described hereafter.

Material and methods

The material was examined using standard microscopic techniques. Examination was performed on squash mounts in water, 10 % KOH solution, and in Lugol's Iodine. All measurements were made in water. Microphotographs were made with a Philips 515 scanning electromicroscope (see acknowledgements).

Taxonomic description

Pronectria minuta Motiej. & Kukwa, **sp. nov.** FIGURES 1-2

MycoBank MB 511508

A Pronectria tibellii *differt ascomatibus (70–100 μm) et sporis (6–8 x 2–3 μm) minoribus. Crescit supra thallum specierum generis* Cladonia *subgeneris* Cladina.

Typus: Russia, Kola Peninsula, central Khibiny Mts., Kukisvumchorr pass, ca. 12 km NNW of Kirovsk, alt. 400 m, among stones in montane tundra, on *Cladonia stellaris* growing on soil, 10.08.2000, J. Motiejūnaitė (BILAS *5327*– holotypus; UGDA-L *12748*– isotypus)

Etymology: From Latin *minutus* (small), in reference to the small size of perithecia and ascospores.

Description: Ascomata perithecia, obpyriform to almost spherical, 70–100 μm wide, immersed in the host thallus, visible only around the ostiolum as wide, rounded to slightly elongate spots, up to c. 25 μm in diam.; outer part of perithecia in section orange to brownish orange, upper part pale pinkish orange, getting hyaline toward the bottom; perithecial wall 5–15 μm wide, composed of few layers of elongate cells c. 7 x 2–2.5 μm; perithecial apex composed of vertically elongated cells merging with the periphyses toward the centrum; a few oily drops emerging from perithecial section; periphyses c. 1.5 μm wide; asci clavate, 20–32(–40) × 4–6 μm, 8–spored, unitunicate, I and K/I–; ascospores with few small guttules, ellipsoid, 1–septate, not constricted at the septum, hyaline, smooth-walled, (5–)6–8 × 2–3.5 μm; spore cells equal in size, but in few spores upper cell was slightly wider than the lower one. Anamorph: not seen.

Hosts — On thalli of *Cladonia arbuscula* s.lat. and *C. stellaris*. The host thalli are slightly (paratype) to strongly (holotype) discoloured when attacked by the fungus.

Ecology and distribution — *Pronectria minuta* has been found growing on *Cladonia stellaris* among montane tundra vegetation in Russia and on

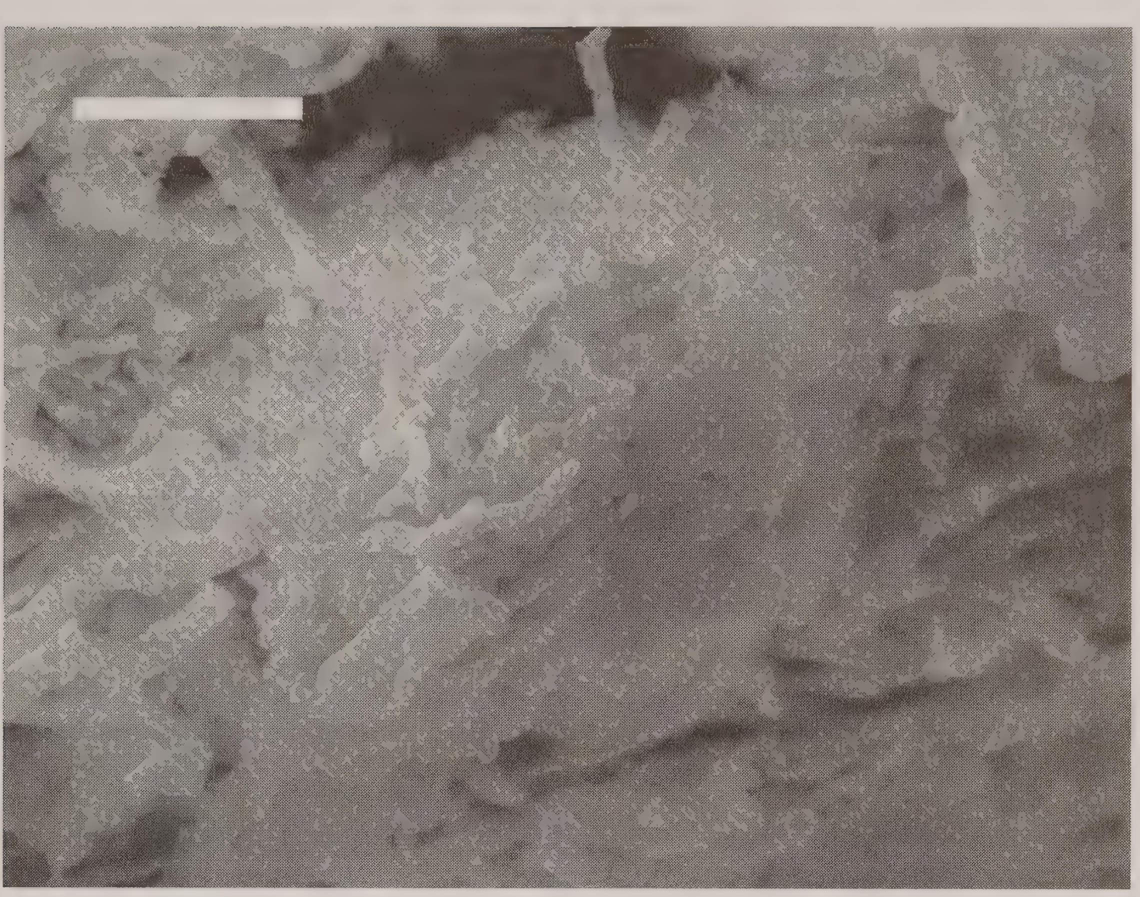

Fig. 1. The perithecium of *Pronectria minuta* on *Cladonia stellaris*; note the wider hyphae of the host around the fruit body, and the thinner hyphae of the fungus (from the holotype; scale 20 μm).

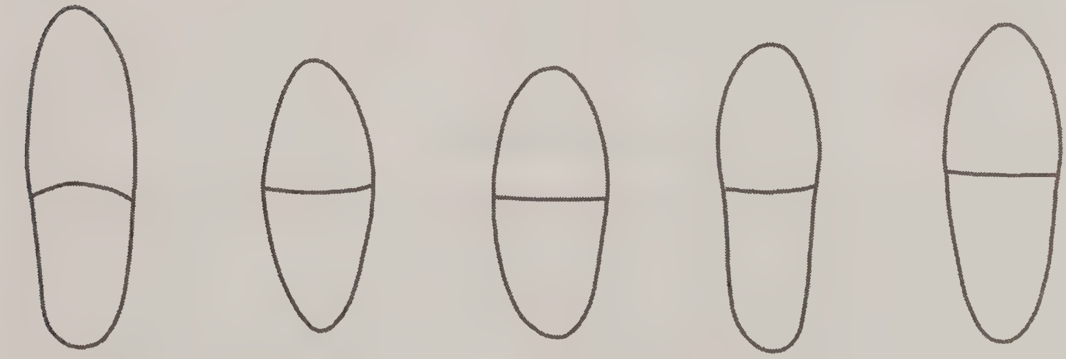

Fig. 2. Ascospores of *Pronectria minuta* (from the paratype; scale 10 μm).

C. arbuscula s. lat. in temperate psammophilous vegetation in Poland. Both hosts contain usnic acid in the thallus as a main secondary lichen metabolite. Taking into account both the distance between localities and the wide distribution of the host species, the new fungus is expected to be also widely distributed. On *C. arbuscula* s. lat., *P. minuta* was found to be associated with an unidentified dematiaceous hyphomycete. This fungus was found in several occasions growing on lower parts of podetia of various *Cladonia* subgen. *Cladina.*

Table 1. The discriminating characters of *Pronectria minuta* and *P. tibellii* (data for the latter after Zhurbenko & Alstrup 2004).

	P. MINUTA	*P.* TIBELLII
PERITHECIA (diameter)	70–100 µm	100–150 µm
ASCI (dimensions)	20–32(–40) × 4–6 µm	70 × 7–8 µm
ASCOSPORE (shape)	ellipsoid	fusiform
ASCOSPORE (dimensions)	(5–)6–8 × 2–3.5 µm	(8–)9.5–13.5(–16) × 3–4.5(–5) µm
ASCOSPORE (wall)	smooth	verruculose
HOSTS	*Cladonia arbuscula* s. lat., *C. stellaris*	*C. pocillum,C. acuminata, C. symphycarpia*
KNOWN DISTRIBUTION	arctic to temperate	arctic

OBSERVATIONS — So far only one species of *Pronectria*, *P. tibellii* Zhurb., has been known to grow on *Cladonia* (Zhurbenko & Alstrup 2004). Both taxa differ predominantly in the size of ascomata, asci and ascospores, but also in the shape of ascospores (Table 1). *P. tibellii* grows mostly on the upper side of basal squamules of the members of the subgenus *Cladonia*, whereas *P. minuta* is confined to podetia of subgenus *Cladina*.

Both subgenera of *Cladonia* have a number of lichenicolous fungi in common, e.g., *Abrothallus cladoniae*, *Bachmanniomyces uncialicola*, *Cercidospora cladoniicola*, *Chaenothecopsis parasitaster*, *Echinothecium cladoniae*, *Lichenoconium pyxidatae*, *Lichenosticta alcicornaria*, *Niesslia cladoniicola*, *Roselliniella cladoniae*, *Scutula epicladonia*, *Syzygospora bachmannii*. On the other hand, at least several species are confined to *Cladonia* subgen. *Cladonia* (*Arthrorhaphis aeruginosa*, *Epicladonia* spp., *Phaeopyxis punctum*, *Polycoccum microcarpum*, *Taeniolella beschiana*, *Tremella cladoniae*) or to subgen. *Cladina* (*Lichenopeltella cladoniarum*, *Sphaerellothecium cladoniicola*, *Taeniolella cladinicola*). These facts were variously interpreted by different authors. With reference to Hafellner et al. (1994), Stenroos et al. (1997) used the fact of common lichenicolous fungi to strengthen the unification of the genera *Cladonia* and *Cladina*, whilst Zhurbenko & Alstrup (2004) used the selectivity of lichenicolous fungi as one of the distinguishing characters between *Cladina* and *Cladonia*. Based on molecular investigations, *Cladina* is not accepted as a separate genus, but still forms a distinct clade within *Cladonia* (DePriest et al. 2000, Stenroos et al. 2002).

Thus far *P. minuta* is known from arctic (northern Russia) and temperate zones (Poland); this suggests that this species has a wider distribution than that of *P. tibellii* (only Subarctic to Arctic Alaska). However, the latter can also be expected to grow in other climatic zones, as at least two of its host species are widely distributed.

Compared to other *Pronectria* species, *P. minuta* differs by extremely small-sized ascomata and ascospores. The smallest ascospores previously known to date occur in *P. microspora* Etayo (Etayo 2002), with spores of 5–6.5(–7.5) × 3–4.5 µm; *P. microscopora* has, however, larger ascomata (100–150 µm) and a different host (*Lobaria pallida*). Four other species in the genus *Pronectria* s.l. (including *Xenonectriella*) — *P. dillmaniae* Zhurb., *P. fissuriprodiens* Etayo, *P. leptalea* (J. Steiner) Lowen and *P. subimperspicua* (Speg.) Lowen — also have small spores. However, the ascospores are all larger than in the new species — (6–)9–11.5(–12) × (4–)5–6(–7) µm in *P. dillmaniae*, 6.5–10 × 3–5 µm in *P. fissuriprodiens*, 6.5–9 × 5–6 µm in *P. subimperspicua*, and 7–11 × 5–9 µm in *P. leptalea*. Ascomata of these three species are larger than in *P. minuta* as well, measuring from 120 to 240 µm (rarely some ascomata slightly smaller) (Clauzade et al. 1989, Etayo 1998, Etayo & Diederich 1996, Rossman et al. 1999, Zhurbenko et al. 2005). All of them also inhabit taxonomically distantly related hosts: *Catapyrenium cinereum* (*P. dillmaniae*), *Lobaria* (*P. fissuriprodiens*), *Punctelia* (*P. subimperspicua*), *Physcia* and *Physconia* (*P. leptalea*).

ADDITIONAL SPECIMEN EXAMINED—**POLAND. Mierzeja Wiślana.** 'Mierzeja Wiślana' Landscape Park, between Piaski village and Krynica Morska village, psammophilous vegetation, on *Cladonia arbuscula* s.lat. growing on sandy soil—11.07.2001, M. Kukwa *842* (UGDA-L *12022*–paratypus, BILAS–isoparatypus).

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Literature cited

DePriest PT, Piercey-Normore M, Sikaroodi M, Kärkkäinen K, Oksanen I, Yahr R, Ahti T. 2000. Phylogenetic relationships among sections of *Cladonia* and *Cladina*. In T Randlane, A Saag (eds.), The Fourth IAL Symposium, Progress and Problems in Lichenology at the Turn of the Millennium, p. 14. Universitat de Barcelona, Barcelona.

Clauzade G, Diederich P, Roux C. 1989. Nelikenigintaj fungoj likenlogaj. Ilustrida determinlibro. Bull. Soc. Linn. Provence, Num. spéc. 1: 1–142.

Etayo J. 1998. Some hypocrealean lichenicolous fungi from Southwest Europe. Nova Hedwigia 67: 499–509.

Etayo J. 2001. Hongos liquenícolas de Ecuador. I. Dos especies nuevas del orden Hypocreales (Ascomycota): *Pronectria parmotrematis* y *Trichonectria leptogiicola*. Anales Jard. Bot. Madrid 58(2): 219–222.

Etayo J. 2002 Aportación al Conocimiento de los Hongos Liquenícolas de Colombia. Biblioth. Lichenol. 84: 1–154 pp.

Etayo J, Diederich P. 1996. Lichenicolous fungi from the western Pyrenees, France and Spain. III. Species on *Lobaria pulmonaria*. Bull. Soc. Natur. Luxemb. 97: 93–118.

Hafellner J, Hertel H, Rambold G, Timdal E. 1994. Discussion 4. Lecanorales. In: DL Hawksworth (ed.), Ascomycete systematics: problems and perspectives in the nineties, pp. 379–387. Plenum Press, New York.

Hansen ES, Alstrup V. 1995. The lichenicolous fungi on *Cladonia* subgenus *Cladina* in Greenland. Graphis Scripta 7: 33–38.

Kondratyuk SY. 1996. New species of *Pronectria, Vouauxiomyces, Wentiomyces* and *Zwackhiomyces* from Australasia. Muelleria 9: 93–104.

Lowen R. 1995. *Acremonium* section *Lichenoidea* section nov. and *Pronectria oligospora* species nov. Mycotaxon 53: 81–95.

Lowen R, Diederich P. 1990. *Pronectria xanthoriae* and *P. terrestris*, two new lichenicolous fungi (Hypocreales). Mycologia 82(6): 788–791.

Rossman AY, Samuels GJ, Rogerson CT, Lowen R. 1999. Genera of *Bionectriaceae, Hypocreaceae* and *Nectriaceae* (*Hypocreales, Ascomycetes*). Stud. Mycol. 42: 1–248.

Stenroos S, Ahti T, Hyvönen J. 1997. Phylogenetic analysis of the genera *Cladonia* and *Cladina* (Cladoniaceae, lichenized Ascomycota). Pl. Syst. Evol. 207: 43–58.

Stenroos S, Hyvönen J, Myllys L, Thell A, Ahti T. 2002. Phylogeny of the genus *Cladonia* s.lat. (Cladoniaceae, Ascomycetes) inferred from molecular, morphological, and chemical data. Cladistics 18: 237–278.

Zhurbenko MP, Alstrup V. 2004. Lichenicolous fungi on *Cladonia* mainly from the Arctic. Symb. Bot. Upsal. 34(1): 477–499.

Zhurbenko MP, Laursen GA, Walker DA. 2005. New and rare lichenicolous fungi and lichens from the North American Arctic. Mycotaxon 92: 201–212.

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Dermoloma inconspicuum from Belize with molecular support for its placement in the *Agaricaceae*

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Abstract – *Dermoloma inconspicuum* is reported from Belize for the first time, extending its known distribution from Venezuela into Central America. Based on nLSU and 5.8s sequence data, *D. inconspicuum* has phylogenetic affinities to the *Agaricaceae* rather than to the *Tricholomataceae* where it has traditionally been placed by taxonomists. Since the species was previously known only from the holotype consisting of a single basidiome, photographs and a detailed description from fresh material are provided here.

Key Words – *Agaricales*, fungi, 5.8s gene, large ribosomal subunit

Introduction

Dermoloma J.E. Lange ex Herink is a relatively small genus characterized primarily by its collybioid to tricholomatoid stature, uniformly hymeniform pileipellis, smooth spores that are inamyloid to amyloid, and lack of other distinguishing characteristics such as cystidia. Species of *Dermoloma* are currently placed in the *Tricholomataceae* and thus far approximately 33 names for taxa have been proposed for the genus (Index Fungorum, www.indexfungorum.org). Judging from the paucity of reports in the literature, no *Dermoloma* species appears to be commonly collected. Although species are sometimes found in forests, *Dermoloma* has not been implicated in ectomycorrhizal relationships. The genus is naturally represented through Europe as well as North and South America (Singer 1986).

In late August 2003, two collections of a distinctive collybioid agaric were made near the Las Cuevas Research Station in western Belize. These specimens were subsequently identified as *Dermoloma inconspicuum*. No other reports of this species could be found beyond the original description by Dennis (1961) and its subsequent inclusion in his work on the fungal flora of Venezuela (Dennis 1970). In addition, no sequences from species of *Dermoloma* were currently available in GenBank; although Singer (1986) placed the genus in the *Tricholomataceae,* this phylogeny has never been tested molecularly.

In this paper, *D. inconspicuum* is documented from Belize and its phylogenetic position is assessed using sequence data from the nuclear large ribosomal subunit and the 5.8s gene. A re-description of this species from fresh material is also given to supplement the original and very brief description by Dennis (1961).

Materials and methods

The specimens were examined and recorded microscopically using light microscopy with a digital camera. Sections from dried herbarium specimens were rehydrated for study in 10% NH_4OH or Melzer's reagent. Color codes were taken from Kornerup & Wanscher (1967). Herbarium acronyms (UTC = Herbarium, Biology Department, Utah Sate University; K = Royal Botanical Gardens, Kew) follow Holmgren et al. (1990).

DNA for the phylogenetic analysis was extracted from an herbarium specimen of *Dermoloma inconspicuum* (UTC 248299) collected in Belize using previously successful standard protocols (Kropp et al. 1996). PCR amplifications of the nuclear large subunit (nLSU) were produced using primers LROR and LR5 (Moncalvo et al. 2000); those of the internal transcribed spacer (ITS) region, including ITS1 and ITS2 with the 5.8s gene, were produced using primers ITS5 and ITS4 respectively (White et al. 1990). Partial DNA sequences of the amplified PCR products from the nuclear large subunit (nLSU) were directly sequenced using primers LROR and LR5 along with internal primers LR22 and LR3R (Moncalvo et al. 2000). ITS and 5.8s gene sequences were obtained using primers ITS4 and ITS5. Reverse sequences were used to check the accuracy of both sequences used in the phylogenetic analysis. The sequences have been deposited in Genbank (nLSU-EU339309, ITS-EU339310).

An initial BAST search using the *D. inconspicuum* nLSU sequence suggested affinities with the *Agaricaceae.* Because of this, taxon sampling for the phylogenetic analysis included representatives of the agaricoid clade in addition to the tricholomatoid and marasmioid clades of Matheny et al. (2006). Two *Hygrophorus* species rooted the tree. Sampling was limited to species and sequences used by the above authors in their proposed phylogeny of the *Agaricales.* Genbank accession numbers for the taxa shown in Fig. 1 are listed by Matheny et al. (2006).

The nLSU and ITS sequences were aligned separately using Clustal X (Thompson et al. 1997) and combined into a single file. After removing all but the 5.8s region from the ITS sequences, the combined data set was realigned and final adjustments were hand aligned. The combined data sets were subjected to the partition-homogeneity test in PAUP* (Swofford 2003) and found to be congruent (p=0.68). A heuristic search for most parsimonious trees was conducted in PAUP* following a two step protocol similar to that of Hibbett & Donoghue (1995). Branch strength was evaluated by doing 100 bootstrap replicates using a heuristic search in PAUP*.

Results

This report, which extends the known distribution of *Dermoloma inconspicuum* northward from Venezuela into Central America, appears to the first and only record of the species since its description. The two collections from Belize agree very well macroscopically with both the painted figure of Dennis (1970) and the brief original Latin diagnosis (Dennis 1961). A comparison of the holotype with the two collections from Belize indicates that they are identical both macroscopically and microscopically. It should be pointed out that there are some discrepancies in the information that Dennis published on *D. inconspicuum*: he describes the basidiospores as weakly amyloid in his Latin description but inamyloid in his subsequent key to Venezuelan species (Dennis 1961, 1970). The current examinations shows that the spores are inamyloid in both the holotype and the newly collected material from Central America.

The phylogenetic analysis based on combined nLSU and 5.8s sequences indicates that *D. inconspicuum* has affinities in the *Agaricaceae* (Fig. 1) rather than in the *Tricholomataceae* where the genus has traditionally been placed. This finding is interesting but rather unexpected. Certainly, when taken together, the white spores, collybioid stature, lack of an annulus, and narrowly attached lamellae of *D. inconspicuum* point to a close association with the *Tricholomataceae*. Nonetheless, certain morphological similarities between *D. inconspicuum* and certain members of the *Agaricaceae* become relevant in light of its putative phylogeny. The hymeniform pileus cuticle observed in *D. inconspicuum* is relatively common throughout the *Agaricaceae*, including such representative genera as *Lepiota* (Pers.) Gray, *Hymenagaricus* Heinem., *Crucispora* E. Horak, and *Chamaemyces* Earle. Of these, *Chamaemyces* probably is the morphologically closest to *D. inconspicuum* in having the combination of a uniformly hymeniform pileipellis, basidiospores that are white, smooth and inamyloid, and a non-lepiotoid stature. In addition, even though the lamellae of *D. inconspicuum* are not free, they are very nearly so, and at least one member of the *Agaricaceae* — *Chamaemyces fracidus* (Fr.) Donk — reportedly (Breitenbach & Kränzlin 1995) has free to finely adnexed lamellae.

The data presented here provide good support for transferring *D. inconspicuum* to the *Agaricaceae*. The questions of whether the entire genus *Dermoloma* is monophyletic or where different species might fit within the *Agaricaceae* must wait until sequence data for other *Dermoloma* species become available .

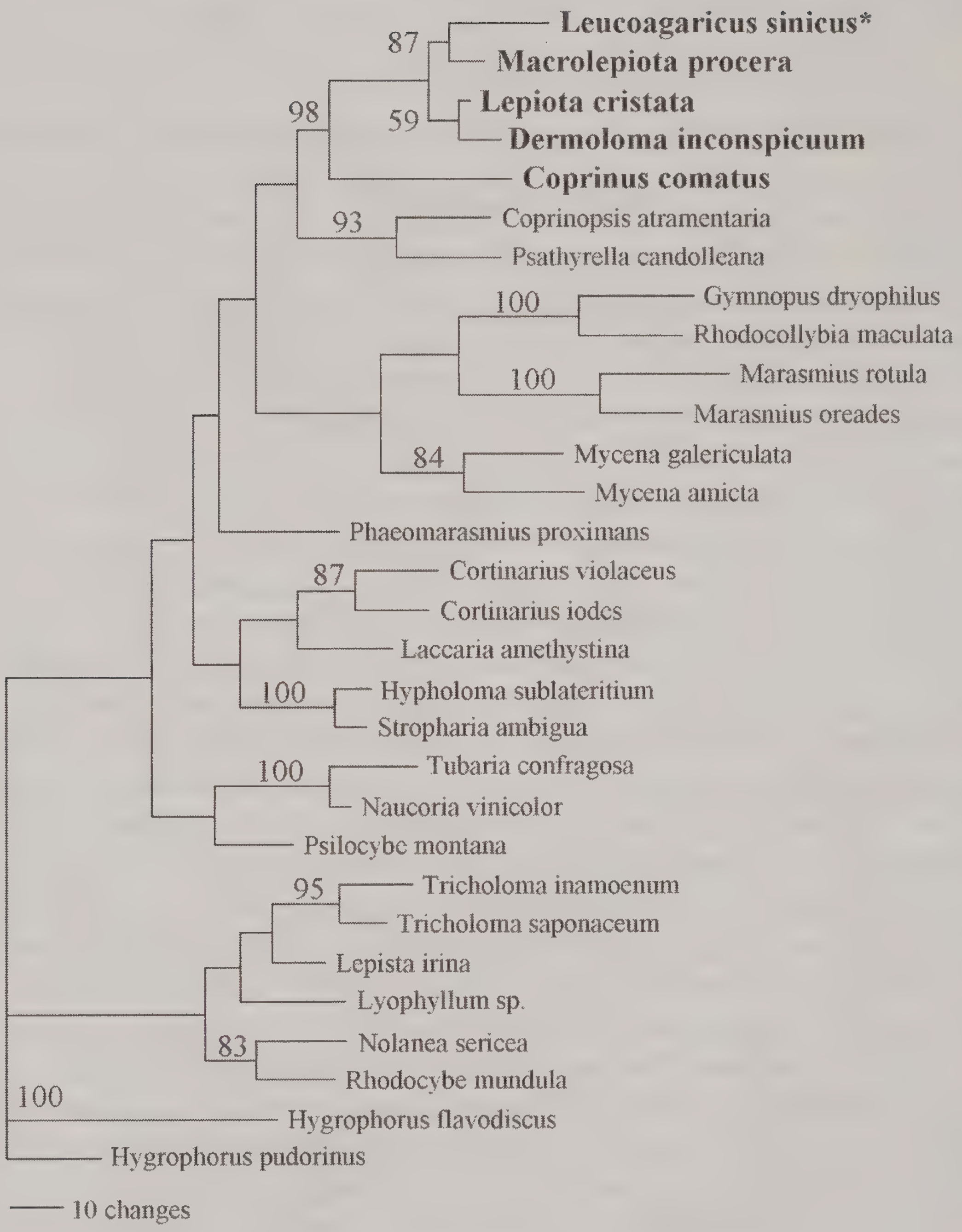
87
98
59
Leucoagaricus sinicus*
Macrolepiota procera
Lepiota cristata
Dermoloma inconspicuum
Coprinus comatus
93
Coprinopsis atramentaria
Psathyrella candolleana
100
Gymnopus dryophilus
Rhodocollybia maculata
100
Marasmius rotula
Marasmius oreades
84
Mycena galericulata
Mycena amicta
Phaeomarasmius proximans
87
Cortinarius violaceus
Cortinarius iodes
Laccaria amethystina
100
Hypholoma sublateritium
Stropharia ambigua
100
Tubaria confragosa
Naucoria vinicolor
Psilocybe montana
95
Tricholoma inamoenum
Tricholoma saponaceum
Lepista irina
Lyophyllum sp.
83
Nolanea sericea
Rhodocybe mundula
100
Hygrophorus flavodiscus
Hygrophorus pudorinus
10 changes

Fig. 1. One of 39 most-parsimonious trees using combined nLSU and 5.8s sequences. *Agaricaceae* representatives are shown in bold font. Numbers indicate bootstrap support above 50%. [**Leucoagaricus sinicus* (J.Z. Ying) Zhu L. Yang (Yang 2007) was cited as *Chamaeota sinica* J.Z. Ying in Matheny et al (2006).]

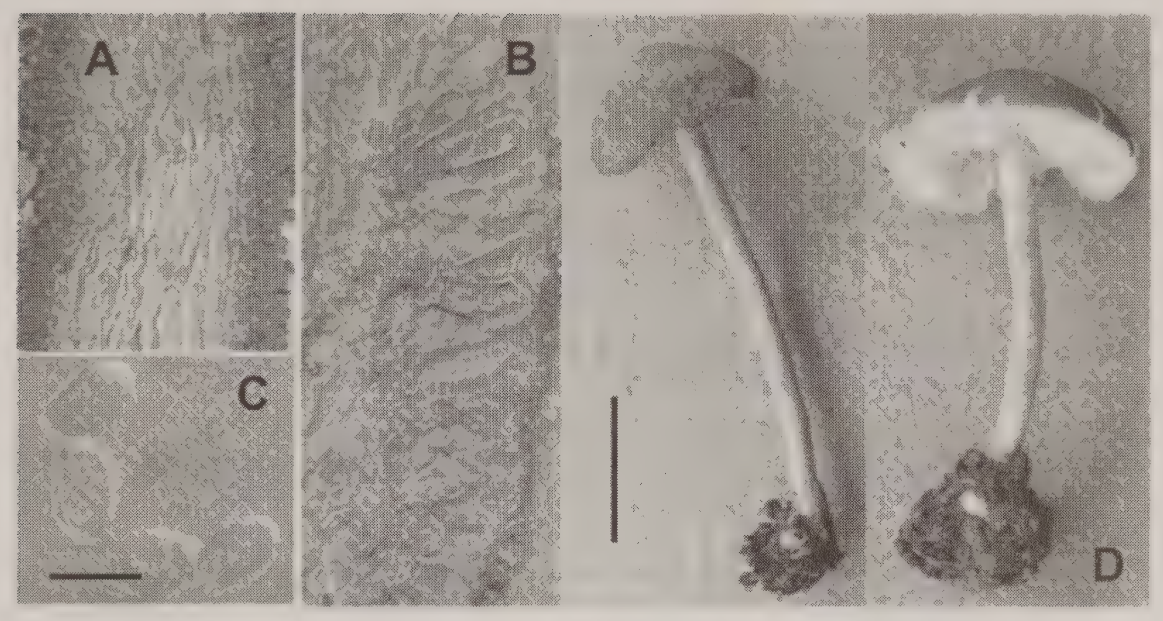

Fig 2. *Dermoloma inconspicuum* (UTC 248299). a) Lamellar trama b) Hymeniform pileipellis c) basidiospores (bar = 5 µm) d) Basidiomata (bar = 1 cm).

Description

Dermoloma inconspicuum Dennis, Kew Bulletin 15: 78. 1961. FIG. 2

PILEUS – 12-20 mm convex to nearly plane at maturity with a low umbo, margin slightly wavy in some, glabrous, dry, cracking in places when dried, uniformly cinnamon brown (7D8), matte; pileus context pallid. LAMELLAE – close, nearly free, whitish. STIPE – 25-40 x 1.5- 2 mm, lacking an annulus or ring zone, smooth, equal to a slightly bulbous base, hollow, pale cinnamon to light pinkish tan (6A3), somewhat tough and pliant; stipe context concolorous with the surface.

BASIDIOSPORES – 3.0-3.5 x 5.0-6.5 µm, elliptical to oblong, smooth, inamyloid, not dextrinoid. BASIDIA – 4-spored, 5-6 x 17-19.5 µm. CYSTIDIA – absent. HYMENOPHORAL TRAMA – hyphae somewhat inflated, interwoven to subparallel. PILEIPELLIS – uniformly hymeniform, consisting of clavate cells 8-14 x 14 -35 µm in size, some with internal brownish pigment; these cells revive slowly in NH_4OH after drying. STIPE SURFACE – smooth, consisting of subparallel hyphae. CLAMP CONNECTIONS – lacking.

HABITAT – scattered on ground in humid tropical forest.

Material Examined – BELIZE, Cayo District, Chiquibul Forest near the Las Cuevas Research Station, coll. B. Kropp 1-Aug-03 (UTC 248299); Belize, Cayo District, Chiquibul Forest near the Las Cuevas Research Station, Coll. B. Kropp 1-Aug-03 (UTC 248300); VENEZUELA, Caracas Botanical Garden, Coll. R. W. G. Dennis, (K 147991, HOLOTYPE).

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Literature cited

Breitenbach J, Kränzlin F. 1995. Fungi of Switzerland, Volume 4, Agarics 2nd part. Edition Mykologia: Lucerne (Switzerland). 368pp

Dennis RWG. 1961. Fungi Venezuelani: IV. *Agaricales*. Kew Bulletin 15: 67-156.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bulletin Additional Series III, Her Majesty's Stationary Office, London. 468pp.

Hibbett DS, Donoghue MJ. 1995. Progress toward a phylogenetic classification of the *Polyporaceae* through parsimony analysis of mitochondrial ribosomal DNA sequences. Can. J. Bot. 73 (Suppl. 1): S853-S861.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. New York Botanical Garden: New York. 693 pp.

Kornerup A, Wanscher JH. 1967. Methuen handbook of colour. London.

Kropp BR, Hansen D, Flint KM, Thomson SV. 1996. Artificial inoculation and colonization of Dyer's Woad (*Isatis tinctoria*) by the systemic fungus *Puccinia thlaspeos*. Phytopathol. 86: 891-896.

Matheny PB, Curtis JM, Hofstetter V, Aime MC, Montalvo J-M, Ge Z-W, Yang Z-L, Slot JC, Binder M, Ammirati JF, Baroni TJ, Bougher NL, Hughes KW, Lodge DJ, Kerrigan RW, Seidl MT, Aanen DK, DeNitis M, Daniele GM, Desjardin DE, Kropp BR, Norvell LL, Parker A, Vellinga EC, Vilgalys R, Hibbett DS. 2006. Six major clades of *Agaricales:* a multilocus phylogenetic overview. Mycologia 98: 982-995.

Moncalvo J-M, Lutzoni FM, Rehner SA, Johnson J, Vilgalys R. 2000. Phylogenetic relationships of agaric fungi based on nuclear large subunit ribosomal DNA sequences. Syst. Biol. 49: 278-305.

Singer R. 1986. The *Agaricales* in modern taxonomy, fourth edition. Koeltz Scientific Books: Koenigstein (Germany). 981pp.

Swofford DL. 2003. PAUP*: Phylogenetic analysis using parsimony (*and other methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucl. Acids Res. 24: 4876-4882.

White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In PCR Protocols a Guide to Methods and Applications. pp. 315-322. MA Innis, DH Gelfand, JJ Sninsky, TJ White eds. Academic Press, Inc.: New York.

Yang ZL. 2007. Type studies on *Chamaeota* species described from China. Mycotaxon 100: 279-287.

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Seven new records of lichenicolous fungi from Turkey

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Abstract — Seven species of lichenicolous fungi (*Arthonia lecanorina, A. oligospora, Lichenostigma rouxii, Merismatium nigritellum, Stigmidium congestum, S. epixanthum, Zwackhiomyces calcariae*) are reported for the first time from Turkey. All these taxa, except *Merismatium nigritellum*, are also new to Asia. Comments on their habitats and substrata and a short diagnosis are provided for each taxon.

Key words — *Ascomycota*, pyrenocarpous fungi, lichens

Introduction

After Hafellner & John (2006) in their review of the lichenicolous fungi of Turkey recognized 63 taxa, interest in them was enhanced and numerous new taxa were described (Halıcı et al. 2005, Halıcı & Hawksworth 2007, 2008, Halıcı et al. 2007a-b, 2008, Hawksworth & Halıcı 2007) or added to the country's biota (Halıcı & Candan 2007, Halıcı et al. 2006, 2007c-f). A key to the 117 lichenicolous fungi of Turkey was recently prepared by Halıcı (2008) and two further additions have been added (Doğru & Güvenç 2007, Yazıcı et al. 2008), bringing the total to 119.

A further contribution to our knowledge of the lichenicolous fungi of Turkey is provided here, with notes on 7 species collected mainly in the province of Malatya, Manisa, Uşak and the Aladağlar National Park (Adana, Niğde, Kayseri). Thus, there now 126 species recorded from Turkey, but this number is small in comparison with some European countries (Santesson 1993, Kocourková 2000, Scholz 2000, Faltynowicz 2003, Hawksworth 2003).

Materials and methods

The specimens detailed here are stored in the herbarium of Erciyes University, (Faculty of Science and Art, Kayseri, Turkey) and ANES (Herbarium of Anadolu University, Science Faculty, Eskişehir, Turkey); their accession numbers are given in parentheses after the locality details. Specimens were examined in water, 10% KOH, Lugol's and Metzler's iodine solutions. Spore measurements were generally determined in KOH, but for thin-walled spores the dimensions were also checked in water. The descriptive notes provided below are based on the Turkish specimens examined.

Species recorded

Arthonia lecanorina (Almq.) R.Sant. 2004

A detailed description is provided by Grube & Matzer (1997).

Specimens were abundant on the apothecia of *Lecanora flotowiana* on calcareous rocks at 1915 m. Epihymenium dark brown to almost black, hymenium hyaline to light brown and hypothecium light brown. Asci 8-spored, 26–35 × 15–16 µm. Ascospores hyaline, 1-septate, 9–11 × 4 µm.

A. lecanorina is distinguished from *A. caerulescens* by its light brownish and thin hypothecium (Grube & Matzer 1997). *Arthonia galactinaria*, which also occurs on the apothecia of the *Lecanora dispersa* group, differs in having brown ascospores when old (Leighton 1879). *Arthonia* species that have 1-septate hyaline ascospores growing on *Lecanora* are taxonomically very problematic and require critical taxonomic studies supported by molecular analyses.

Arthonia lecanorina is also reported from Luxembourg and France on the apothecia of *Lecanora albescens* and *L. dispersa* (Diederich & Sérusiaux 2000). New to Asia.

KAYSERI: *Yahyalı, Aladağlar Milli Parkı, Köşkderesi yanı, 37° 58' N, 35° 17' E, alt. 1915 m, on the apothecia of Lecanora flotowiana on exposed calcareous rocks, 03 Oct 2004, M. G. Halıcı (MGH 0.1761).*

Arthonia oligospora Vězda 1973

A description is provided by Clauzade et al. (1989).

A. oligospora was collected from the thallus of *Aspicilia* sp. on calcareous rocks at 1200 m. Epihymenium olivaceous-green, hypothecium dark brown. Asci 4-spored. Ascospores hyaline, 1-septate, (12.5–)14–16 × 6.5–7 µm.

In Bulgaria *Arthonia oligospora* has been found on the thallus and apothecia of *Lecanora crenulata*. It is also known from Spain on a saxicolous, calcicolous lichen (Clauzade et al. 1989). New to Asia

MALATYA: Darende, East of Darende Town, 38° 34' N, 37° 31' E, alt. 1200 m, on *Aspicilia* sp. on exposed calcareous rock, 09 Aug. 2007, *M. Candan* (ANES 11177).

Lichenostigma rouxii Nav.-Ros., Calat. & Hafellner 2002

A detailed description is provided by Calatayud et al. (2002).

L. rouxii was abundant on the thallus of *Squamarina cartilaginea*. Superficial vegetative hyphae, forming dense black strands on the surface of the host, are mostly simple and reach 1500 µm long and 15 µm thick. Ascomata black, ± elongated. Asci 8-spored, 28–34 × 20–22 µm. Ascospores brown when mature, 1-septate, the upper cell slightly larger, 12–13 × 6–7 µm.

Lichenostigma rouxii is common in Europe on *Squamarina* species (Calatayud et al. 2002), but it is new to Asia.

MANISA: Kula, Northwest of Kula town, 38° 34' N, 28° 38' E, alt. 680 m, on thallus of *Squamarina cartilaginea* on calcareous rocks, 14 Aug. 2006, *M. Candan* (ANES 11178).

Merismatium nigritellum (Nyl.) Vouaux 1913

Descriptions are provided by Triebel (1989) and Clauzade et al. (1989).

M. nigritellum was collected from the thallus of *Placidium lachneum* on calcareous soil at 2050 m. Vegetative hyphae superficial, dark brown, 2.5–3 µm. Ascomata perithecia, black, 250–300 µm. Hamathecium of septate periphysoids, 18–25 × 1–2 µm. Asci 8-spored, 80–120 × 23–26 µm. Ascospores irregularly arranged in the asci, dark brown, submuriform with 4–6 trans-septa, 2–3 vertical-septa, 24–27 × 9–10 µm. Probably commensalistic, as no damage to the host was observed.

In Scotland *Mirismatium nigritellum* occurs on *Placidium rufescens*; it has also been recorded from several European countries and Russia on *Placidium lachneum*, *Leptogium* sp., *Micarea* sp., *Mycobilimbia berengeriana* and *Omphalina hudsoniana* (Triebel 1989). Kocourková (2000) lists additional hosts.

ADANA: Aladağlar Milli Parkı, Acıman Yaylası, Turhasan Tepesi, 37° 44' N, 35° 16' E, alt. 2050 m, on thallus of *Placidium lachneum* on calcareous soil, 31 Aug. 2005, (MGH 0.1993).

Stigmidium congestum (Körb.) Triebel 1991

A detailed description is provided by Roux & Triebel (1994).

S. congestum was collected on the apothecia of *Lecanora intumescens* on *Juniperus* sp. Ascomata perithecia, black, 50–60 µm wide, ± elongate. Asci 8-spored. Ascospores 1-septate, hyaline, upper cell slightly larger, 12–15 × 3 µm. Evidently pathogenic, as discolouration was observed in the host's apothecia, especially in the later stage of infection.

Stigimidium congestum is common on the apothecia and (rarely) vegetative thalli of corticolous *Lecanora* species in Europe and North America (Triebel et al. 1991). New to Asia!

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Ulupınar Village, Uzuncalan Mevkii, 37° 49' N, 35° 21' E, alt. 1120 m, on apothecia of *Lecanora intumescens* on *Juniperus* sp., 24 Aug. 2006, *M. G. Halıcı* (MGH 0.2326).

Stigmidium epixanthum Hafellner 2002

Detailed descriptions are provided by Hafellner et al. (2002) and Triebel & Cáceres (2004).

S. epixanthum was collected from the thallus of *Acarospora schleicheri* (which starts its life cycle as a parasite on *Diploschistes muscorum*) on siliceous soil. Ascomata perithecia, black, sessile, 120–150 µm high, 150–180 µm wide; inhabiting the edges of the areoles as noted by Triebel & Cáceres (2004). Ascomatal wall consisting of two layers, outer dark brown, inner hyaline to pale brown. Asci 8-spored, 41.5–53.5 × 13–16 µm. Ascospores hyaline, 1-septate, upper cell slightly thicker, 12–15 × 5–6 µm. No vegetative hyphae observed. Appears to be commensalistic, as no damage or discolouration was observed in the host thallus.

Stigmidium epixanthum is common on areoles of thalli and (occasionally) apothecial discs of yellow *Acarospora* species such as *A. heufleriana*, *A. lavicola*, *A. radicata*, *A. schleicheri* and *A. xanthophana* in Africa, Australia and America (Triebel & Cáceres 2004). New to Asia!

UŞAK: North of Kısık Village, 38° 37' N, 28° 56' E, alt. 500 m, on thallus areoles of *Acarospora schleicheri* on siliceous soil, 14 Aug. 2006, *M. Candan* (ANES 11179).

Zwackhiomyces calcariae (Flagey) Hafellner & Nik. Hoffm. 2000

A detailed description is provided by Hoffmann & Hafellner (2000).

The specimen was collected from the thallus of *Aspicilia farinosa*. Ascomata perithecia, black, 200–250 µm diam. Asci (4–)6-spored, bitunicate, cylindrical, 80–94 × 15–19 µm. Ascospores irregularly arranged in the asci, 1-septate, the upper cell larger and ± constricted at the septa, 19–23 × 6–7 µm. In the original description of this species, it is reported that asci are 8-spored and ascospores 15–20 × 6–7 µm (Hoffmann & Hafellner 2000).

Zwackhiomyces calcariae occurs on *Aspicilia calcarea* in Algeria (Hoffmann & Hafellner 2000). Reports of *Didymella sphinctrinoides* var. *aspiciliicola* from Austria, France, Switzerland and Italy probably represent *Z. calcariae* (Hoffmann & Hafellner 2000). The species is referred to *Aspicilia calcarea* in the Czech Republic (Kocourková & Van Den Boom 2005). New to Asia!

MALATYA: Darende, East of Darende Town, 38° 34' N, 37° 31' E, alt. 1200 m, on *Aspicilia farinosa* on exposed calcareous rocks, 09 Aug. 2007, *M. Candan* (ANES 11180).

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Literature cited

Calatayud V, Navarro-Rosinés P, Hafellner J. 2002. A synopsis of *Lichenostigma* subgen. *Lichenogramma* (*Arthoniales*), with a key to the species. Mycological Research 106: 1230-1242.

Clauzade G, Diederich P, Roux C. 1989. Nelikenigintaj fungoj likenlogaj. Bulletin de la Société linnéenne de Provence, numéro spécial 1: 1-142.

Diederich P, Sérusiaux E. 2000. The lichens and lichenicolous fungi of Belgium and Luxembourg. An annotated checklist. Musée National Histoire Naturalle, Luxembourg. 1-207.

Dogru Z, Güvenç Ş. 2007. Lichenized and lichenicolous fungi from Bursa province new to Turkey. Mycotaxon 102: 389-394.

Fałtynowicz W. 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. Biodiversity of Poland 6: 1-435.

Grube M, Matzer M. 1997. Taxonomic concepts of lichenicolous *Arthonia* species. Bibliotheca Lichenologica 68: 1-17.

Hafellner J, John V. 2006. Über funde lichenicoler nicht-lichenisierter Pilze in der Türkei, mit einer Synopsis der bisher im Land nachgewiesenen Taxa. Herzogia 19: 155-176.

Hafellner J, Triebel D, Ryan BD, Nash TH III. 2002. On lichenicolous fungi from North America. II. Mycotaxon 84: 293-329.

Halıcı MG. 2008. A key to the lichenicolous *Ascomycota* (including mitosporic fungi) of Turkey. Mycotaxon: in press.

Halıcı MG, Candan M. 2007. Notes on some lichenicolous fungi from Turkey. Turkish Journal of Botany 31: 353-356.

Halıcı MG, Hawksworth DL. 2007. Two new species of lichenicolous fungi from Turkey. Lichenologist 39: 439-443.

Halıcı MG, Hawksworth DL. 2008. Two new species of *Dacampia* (*Ascomycota*, *Dacampiaceae*), with a key to and synopsis of the known species of the genus. Fungal Diversity 28: 49-54.

Halıcı MG, Orange A, Aksoy A. 2005. *Weddellomyces turcicus*, a new species on a grey *Acarospora* from Turkey. Mycotaxon 94: 249-252.

Halıcı MG, Kocakaya M, Aksoy A. 2006. Additional and interesting lichenized and lichenicolous fungi from Turkey. Mycotaxon 96: 13-19.

Halıcı MG, Kocourková J, Diederich P, Aksoy A. 2007a. *Endococcus variabilis*, a new species on *Staurothele areolata*. Mycotaxon 100: 337-342.

Halıcı MG, Atienza V, Hawksworth DL. 2007b. Two new *Polycoccum* species from Turkey. Mycotaxon 101: 157-163.

Halıcı MG, Özdemir Türk A, Candan M. 2007c. New records of pyrenocarpous lichenicolous fungi from Turkey. Mycotaxon 99: 201-206.

Halıcı MG, Candan M, Özdemir Türk A. 2007d. New records of lichenicolous and lichenized fungi from Turkey. Mycotaxon 100: 255-260.

Halıcı MG, Hawksworth DL, Aksoy A. 2007e. Contributions to the lichenized and lichenicolous fungal biota of Turkey. Mycotaxon 102: 403-414.

Halıcı MG, Hawksworth DL, Aksoy A. 2007f. New and interesting lichenicolous fungi records from Turkey. Nova Hedwigia 85: 393-401.

Halıcı MG, Özdemir Türk A, Candan M. 2008. *Dacampia cladoniicola* sp. nov. (*Ascomycota*, *Dacampiaceae*), on *Cladonia* sp. from Turkey. Mycotaxon 103: 53-57.

Hawksworth DL. 2003. The lichenicolous fungi of Great Britain and Ireland: an overview and annotated checklist. Lichenologist 35: 191-232.

Hawksworth DL, Halıcı MG. 2007. *Gemmaspora*, a new verrucarialean genus with remarkable ascospores for *Adelococcus lecanorae* growing on *Aspicilia* species in Syria and Turkey. Lichenologist 39: 121-128.

Hoffmann N, Hafellner J. 2000. Eine Revision der lichenicolen Arten der Sammelgattungen *Guignardia* und *Physalospora*. Bibliotheca Lichenologica 77: 1-181.

Keissler K. 1930. Die Flechtenparasiten. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz 8: i- xi, 1-712.

Kocourková J. 2000. Lichenicolous fungi of the Czech Republic (the first commented checklist). Acta Musei Nationalis Pragae, B55: 59-169.

Kocourková J, Van Den Boom PPG. 2005. Lichenicolous fungi from the Czech Republic II. *Arthrorhapsis arctoparmeliae* sp. nov. and some new records for the country. Herzogia 18: 23-35.

Leighton WA. 1879. Lichen flora of Great Britain, Ireland, and the Channel Islands. 3rd edn. Shrewsbury.

Roux C, Triebel D. 1994. Révision des espéces de *Stigmidium* et de *Sphaerellothecium* (champignons lichénicoles on lichénisés, ascomycetes) correspondant á *Pharcidia epicymatia* sensu Keissler ou á *Stigmidium schaereri* auct. Bull. Soc. Linn. Provence 45: 451-542.

Santesson R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. Lund, 1-240.

Scholz P. 2000. Katalog der Flechten und flechtenbewohnenden Pilze Deutschlands. Schriftenreihe der Vegetationskunde 31: 1-298.

Triebel D. 1989. Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. Bibliotheca Lichenologica 35: 1-278.

Triebel D, Cáceres MES. 2004. *Stigmidium*, pp. 703-707. In: Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F., ed. 2004. Lichen Flora of the Greater Sonoran Desert Region.Vol. 2. Tempe: Arizona State University.

Triebel D, Rambold G, Nash TH III. 1991. On lichenicolous fungi from continental North America. Mycotaxon 42: 263-296.

Yazıcı K, Aptroot A, Aslan A. 2007. Six lichenized and non-lichenized fungi new to Turkey. Mycotaxon 102: 307-313.

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Lasiosphaeriopsis lecanorae sp. nov. (*Ascomycota, Nitschkiaceae*) on *Lecanora polytropa* from Spain with a key to the known species of the genus

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Abstract — *Lasiosphaeriopsis lecanorae* is described as new from a collection of *Lecanora polytropa* in Spain. It differs from the other members of the genus in the constantly 8-spored asci. A key to the known species of the genus is provided.

Key words — lichens, lichenicolous fungi, Munk pores

Introduction

The genus *Lasiosphaeriopsis* D. Hawksw. & Sivan. (Hawksworth 1980) comprises six lichenicolous species (www.indexfungorum.org). It typically has unitunicate asci without any discernible apical apparatus, transseptate brown ascospores and ascomata with pseudoparenchymatous cells with perforations called "Munk pores" (Hawksworth 1980). The previously described species were recently compared by Zhurbenko & Triebel (2005).

A collection on the areoles of *Lecanora polytropa* from Spain differs from the other species of the genus by having constantly 8-spored asci, and it is here described as a new species. As there was no key available to the species of the genus, such a key is given.

Material and methods

The type material of the new species is deposited in MAF (Madrid). The specimen was examined under a Nikon SMZ 1500 stereomicroscope, fitted with a Nikon DXM 1200 F digital image system. Ascomatal hand-cut sections were studied in distilled water, KOH, I (Lugol's iodine) and K/I, KOH followed by I treatment, under a Nikon Eclipse 80i microscope fitted with 'Nomarski' differential interference contrast and a Nikon DS-Fi1 digital image system. Measurements of the length and breadth were made in water, obtained using a Nikon Image Analyze System. For ascospore size, the range was calculated after manually rejecting 10% of the highest and 10% of the lowest measured values; the average is given in italics, and the lowest and highest extreme values are given between parentheses. The length/breadth (l/b) ratio of the ascospores is given in the same way.

The species

Lasiosphaeriopsis lecanorae Pérez-Ortega & Halici, **sp. nov.** FIGURE 1

MycoBank MB 511455

Fungus lichenicola in thallo Lecanorae polytropae *crescens. A* Lasiosphaeriopsis christiansenii *differt ascosporis minoribus et ascis 8-sporis.*

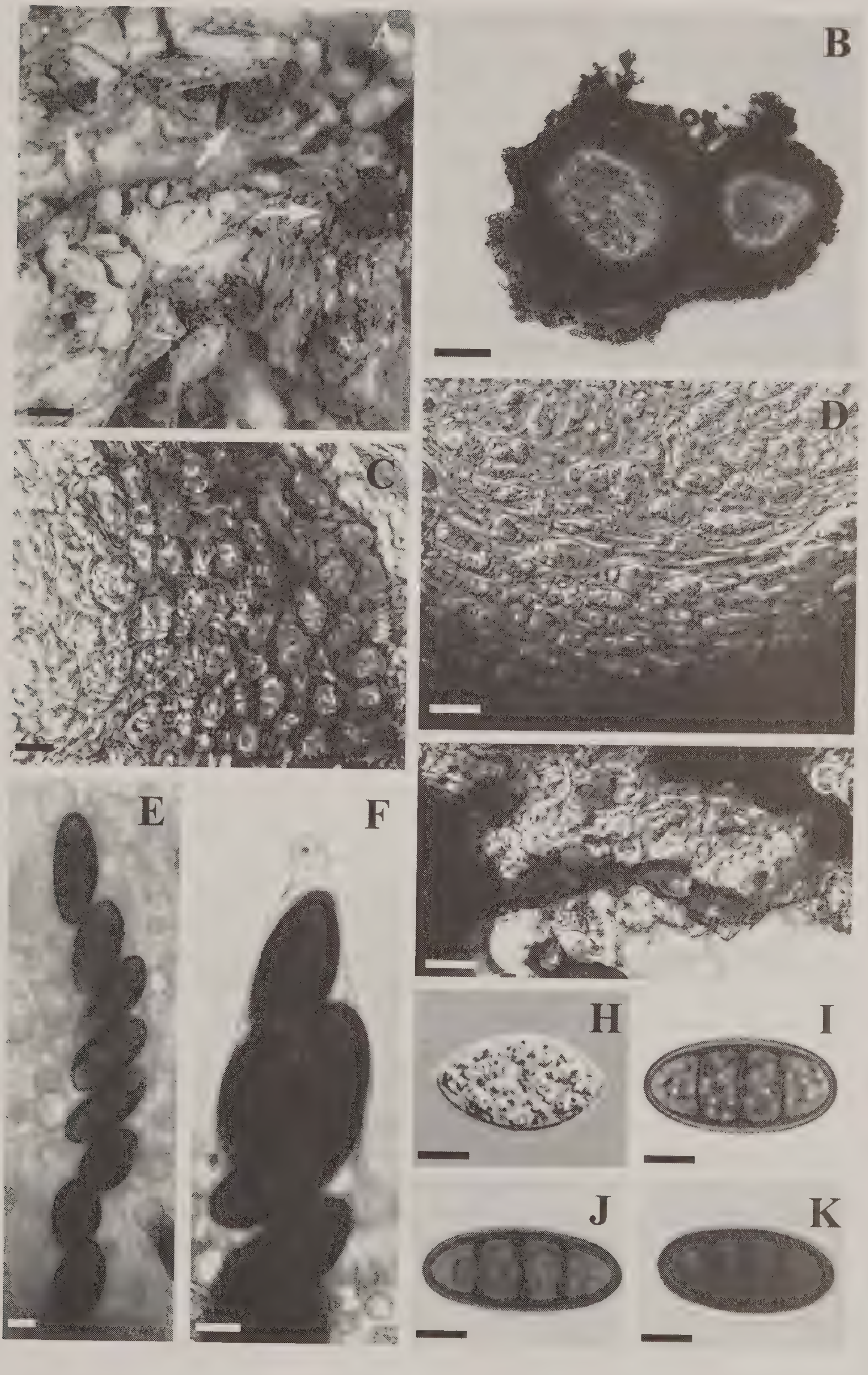
Typus: Spain, Castilla y León, Segovia province, Riaza, rock outcrop close to Pico del Lobo peak, 41° 11' 16" N, 3° 28' 7.8" W, 2137 m, 1.XI.2007, *Pérez-Ortega et al.* (MAF–**holotype**)

Description: Lichenicolous, on the areoles of *Lecanora polytropa*, commensalistic. Vegetative hyphae dark reddish brown, ± branched, torulose and constricted at the septa with cells of 7–14 × 4–8 μm, immersed in host tissues, connecting the ascomata, more or less dense. Ascomata stromatic, perithecial black, with carbonaceous aspect, subglobose to pyriform, or sometimes conical owed to the occurrence of numerous perithecia growing together, surface tuberculate, 200–285 μm in diam, 200–315 μm high, usually with an irregular protruding ostiole, sometimes with striate splits in older ascomata, immersed in the stroma up to almost sessile when growing in small number, usually clustered in groups by 2–9 growing between host areoles. Ascomatal wall unequal in thickness, 40–75 μm in the upper part and 25–45 μm in the lower part, brown throughout, sometimes with a reddish tinge, turning darker or with an olive tinge in K; textura angularis in transverse sections, composed of two clearly differentiated layers: the outermost layer is thicker, composed of up to ten layers of more or less isodiametric dark brown cells, 6–11 × 4–6 μm,

Fig. 1. *Lasiosphaeriopsis lecanorae.* A: Habitus, arrows pointing to different ascomata on squamules of *Lecanora polytropa*; B: Tranverse section of two ascomata in a stroma; C: Detail of external pigmented part of ascomatal wall; D: Detail of hyaline inner part of ascomatal wall; E: Ascus containing 8 spores; F: Detail of apical part of an ascus; G: Vegetative hyphae within stroma; H: Young hyaline ascospore; I: Immature pale brown ascospore; J: Mature ascospore; K: Old ascospore, where it is possible to observe the occurrence of longitudinal septa.

All microscopical photos in water, except C, F & G in KOH.

Scale bars: A: 150 μm; B: 75 μm; C, D, E, F, G: 10 μm; H, I , J, K: 5 μm.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and the inner one hyaline, with strongly compressed cells, 10–20 × 2.5–6 µm; with Munk pores. HAMATHECIUM of ostiolar filaments; interascal filaments not observed. Ascomatal cavity filled with abundant oil droplets, which are evidently mostly included in abortive asci as suggested by Zhurbenko & Triebel (2005). ASCI unitunicate, with wall even in thickness, without tholus and discernible apical apparatus, narrowly cylindrical, 80–125 × 12–19 µm (n = 10), 8-spored, I–, K/I –. ASCOSPORES with 3 transverse septa (very rarely 1–2 oblique additional septa), not constricted at the septa, uniseriately arranged and partly overlapping and inclined in the asci, evenly dark brown, elliptic to almost oblong, straight, very rarely bent, apices usually rounded, sometimes a bit attenuated, wall smooth, up to 2 µm thick, without halo; often with one large guttule in each cell (17–)18.5–*20*–21(–23) × (7–)8.5–9–10(–10.5) µm (n = 45), l/b = (1.7–)2–*2.2*–2.4(–2.8). Immature ascospores thick-walled and hyaline. CONIDIOMATA not observed.

ECOLOGY AND DISTRIBUTION: The new species is known only from the type locality, where it develops over areoles of *Lecanora polytropa*, without causing any visible damage to the host thallus. This locality is characterized by a cryomediterranean climate (Rico 1983). The record of *Lasiosphaeriopsis christiansenii* from Svalbard (Alstrup & Olech (1993) could also refer to our new species as it was found on the same host. Unfortunately that specimen is very old and perithecia are almost empty, and therefore the identification was mostly based on the general appearance and ascospore characters (V. Alstrup, pers. comm.).

OBSERVATIONS: *Lasiosphaeriopsis lecanorae* is distinguished from the other members of the genus in having constantly 8-spored asci. The presence of 8-spored asci enlarges the concept of the genus, as it was originally described as “asci [...] 2-4 spori” (Hawksworth 1980), although 5-6-spored asci were already found in other species (e.g. *L. pilophori* or *L. stereocaulicola*). We do not think that this character is enough to assign the new taxon to a different genus since all other characters fit perfectly with the current circumscription of *Lasiosphaeriopsis* (Hawksworth 1980, Triebel 1989). The species most similar to *L. lecanorae* is *L. christiansenii*, described by Alstrup & Hawksworth (1990) on the areoles of *Porpidia tuberculosa*. This species differs from *L. lecanorae* in having 4-spored asci, a different host, and longer and larger ascospores ((24–)26–35(–37) × 9.5–11 µm) (Alstrup & Hawksworth 1990). *L. supersparsa*, which is known from the areoles of *Porpidia zeoroides*, has ascospores similar in size [(19–)20–23(–24) × (8.5–)9–10.5(–11) µm] to *L. lecanorae*, but 4(5–)-spored asci and vegetative hyphae with a different tinge (Triebel 1989).

Key to the known species of *Lasiosphaeriopsis*

1. Asci 8-spored .... *L. lecanorae*
1. Asci 4(-5)-spored 2
2. Ascospores usually 3-septate 3
2. Ascospores with more than 3 septa 6
3. Ascospores 30-39(-41) µm, end cells paler than central ones, on *Peltigera* spp. .... *L. salisburyi*
3. Ascospores shorter, with an even brown coloration, on different hosts 4
4. Ascospores (19-)20-23(-24) µm long, on *Porpidia zeoroides* .... *L. supersparsa*
4. Ascospores longer 5
5. Ascospores (24-)26-35(-37) µm long, on *Porpidia* spp. .... *L. christiansenii*
5. Ascospores (20-)22.5-29.5(-37) µm long, on *Amygdalaria* spp. ... *L. cephalodiorum*
6. Ascospores (18-)22.5-28.5(-41) µm long, on *Pilophorus* spp. .... *L. pilophori*
6. Ascospores longer, (18-)28.5-39(-50) µm long, on *Stereocaulon* spp. .... *L. stereocaulicola*

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Literature cited

Alstrup V, Hawksworth DL. 1990. The lichenicolous fungi of Greenland. Medd. Grønl. Bioscience 31: 1-90.

Alstrup V, Olech M. 1993. Lichenicolous fungi from Spitbergen. Polish Polar Research 14: 33-42.

Hawksworth DL. 1980. Notes on some fungi occurring on *Peltigera*, with a key to accepted species. Transactions of the British Mycological Society 74: 363-386.

Rico VJ. 1983. Líquenes de los pisos oro- y criomediterráneos del Pico Lobo (Sierra de Ayllon, Segovia). BsC Thesis, ined. Univ. Autónoma Madrid. 304 pp.

Triebel D. 1989. Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. Bibliotheca Lichenologica 35: 1-278.

Zhurbenko MP, Triebel D. 2005. *Lasiosphaeriopsis pilophori* sp. nov. (*Sordariales*) and other lichenicolous fungi on *Pilophorus*. Mycological Progress 4: 317-323.

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A key to the lichenicolous *Ascomycota* (including mitosporic fungi) of Turkey

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Abstract — A key for the identification of 117 specific and infraspecific lichenicolous fungal taxa and one unnamed pycnidial anamorph reported from Turkey is provided. *Arthonia excentrica, Carbonea supersparsa, Endococcus exerrans, Lichenostigma rugosum, Muellerella ventosicola* and *Roselliniella cladoniae* are reported from Turkey for the first time. *Arthonia epiphyscia* which was previously reported from Manisa, Turkey is a misidentification of *Arthonia phaeophysciae.* References to publications in which further information on the taxa can be found are included. Also, the distributions of the taxa in Turkey and the corresponding publications are presented. An index to the names of fungi and a host index are also provided.

Key words — lichenicolous fungi, lichens, coelomycetes, hyphomycetes

Introduction

Lichenicolous fungi are fungi that obligately live on lichens, whether as parasites, commensals or saprobes, at least at some stage in their life-cycle. However, it is not always easy to draw any boundary between lichenicolous fungi and lichenicolous lichens as these lichens start out as fungal invaders of lichen thalli and then by taking the host's photosynthetic partner, kill the host and become completely independent or form colonies with either an independent or the same photobiont on the host lichen thallus (Hawksworth 1988; Richardson 1999; Hawksworth 2003). I preferred here not to include lichen-forming fungi that have a lichenicolous fungal stage in their life-cycle, and include only those that remain lichenicolous fungi and do not form an independent lichen thallus. Also, the lichenicolous basidiomycetous fungi and their mitosporic states are not treated here.

The lichens were one of the least explored ecological niches for other fungi, because of the inadequate literature and a confused taxonomy based largely on nineteenth century concepts (Hawksworth 1983). But recently, with new keys (Hawksworth 1983, Alstrup & Hawksworth 1990, Foucard 2001, Nash et al. 2004, Ihlen & Wedin 2008) and checklists (e.g. Santesson 1993, Kocourková

2000, Diederich & Sérusiaux 2000, Scholz 2000, Faltynowicz 2003, Hawksworth 2003) published, these biologically intriguing taxa have started to receive more attention.

More than 1500 species of lichenicolous fungi had been described by 2003 (Lawrey & Diederich 2003), and 3–4000 are estimated worldwide (Hawksworth 2001). After Hafellner & John (2006) compiled the information of lichenicolous fungi in Turkey, recognizing 63 taxa, I started to investigate the lichenicolous fungal biota of Turkey mainly under the direction of David L. Hawksworth; and one new genus (Hawksorth & Halıcı 2007) and nine new species of lichenicolous fungi have been described (Halıcı & Hawksworth 2007, 2008; Halıcı et al. 2005a, 2007a–b, 2008) from Turkey as a result of this collaboration. Also notes on new records for the country have been published (Halıcı & Candan 2007, Halıcı et al. 2006, 2007c–g). So far, 117 specific and infraspecific lichenicolous taxa have been reported from Turkey, including six new records published here. This total is small compared with other European countries which are smaller geographically and less varied in climate than Turkey (Faltynowicz 2003, Hawksworth 2003, Scholz 2000, Santesson 1993, Kocourková 2000), and at least 250 might be expected (Halıcı et al. 2007e). To increase interest in lichenicolous fungi in Turkey, I have prepared this identification guide, which I believe will be a starting point for enhanced interest in the lichenicolous fungi of Turkey.

Material and methods

Material of 80 of the 117 taxa (69%) and one anamorph included here have been studied personally in the herbaria of Erciyes University, ANES and ANK; these taxa are indicated by * and are keyed according to the observed characters. For the others where I have not seen original material (31%), published data were used. I have tried to provide as much information as possible in the key, and added references to more detailed descriptions for most of the taxa treated. Because the taxonomy in the genus *Stigmidium* is currently host-based, that part of the key is largely host-based, but in general, hosts have been avoided in making separations in the key. A map showing the geographical provinces of Turkey is presented (Figure 1), and vehicle registration codes for each province (Table 1) are used to summarize the distribution of the taxa in Turkey. An index to the names of fungi (Table 2) and a host index (Table 3) are also provided.

Definitions of mycological terms used in this key can be found in Sutton (1980), Hawksworth (1979a) and Kirk et al. (2001). Although seven types of hamathecial filaments were recognized by Eriksson (1981), that terminology was based on ontogenetic development. To simplify the use of the key, a neutral terminology for these tissues is adopted: interascal filaments (any hyphae or tissue between the asci that are branched and/or anastomosing or not) and periphyses (any hyphae or tissue in the upper part of the fruiting body or near the ostiole). Abbreviations of authors names follow IPNI (2008).

Specimens were examined with an Olympus BH-2 research microscope fitted with Nomarski differential interference contrast optics. Squash preparations and sections cut with a razor blade were studied for routine examinations. Some detailed microscopic examinations required sections cut with a freezing microtome. Specimens were examined in water, 10% KOH, Lugol's and Metzler's iodine solutions, Congo red (1% solution in water, mixed 1:1 with 10% KOH) or lactofuchsin. Spore measurements were generally carried out in KOH, but in the case of thin-walled spores the dimensions were also checked in water.

Key to the species

1. Spores produced in asci 2
1. Spores not produced in asci 96

2(1). Ascomata arthonioid, lirelliform, calicioid or apothecioid 3
2. Ascomata stromatic or perithecioid 39

3(2). Ascomata stalked 4
3. Ascomata sessile 5

4(3). Ascomata calicioid; distinctly stalked, K + green (squash). Ascospores brown, 1-septate, 7–9 × 2.5–3 µm. On *Chaenotheca chrysocephala*. See Tibell (1999). Distribution: 14 (Çobanoğlu & Akdemir 2004)
.... ***Chaenothecopsis consociata*** (Nádv.) Alb. Schmidt 1970

4. Apothecial stalk shorter than the hymenial layers, apothecia sometimes ± sessile; exciple reddish, K + violet red. Ascospores brown, non-septate, 5–7.5 × 4.5–7 µm. On apothecia of *Pertusaria* sp. See Löfgren & Tibell (1979). Distribution: 07 (John 1996), 53 (John & Breuss 2004)
.... ***Sphinctrina turbinata*** (Pers.) De Not. 1846

5(3). Ascomata lirelliform 6
5. Ascomata rounded, lecideoid, arthonioid or effuse 8

6(5). Ascospores 1-septate, brown at maturity, smooth-walled, without a conspicuous sheath, 17–20 × 6.5–8 µm. On apothecia of *Pertusaria* sp. See Hawksworth (1982). Distribution: 35, 70 (Hafellner & John 2006)
.... ***Melaspilea canariensis*** D.Hawksw. 1982

6. Ascospores 3-septate 7

7(6). Ascospores brown, 21–24 × 7–8 µm. Hymenium hyaline; epihymenium brown, K–, hypothecium brown, K–. On thallus of *Lecanora sulphurata*. See Keissler (1930). Distribution: 61 (Hafellner & John 2006)
.... ***Opegrapha glaucomaria*** (Nyl.) Källsten ex Hafellner 1994

7. Ascospores brown, 18–24 × 4–7 µm. Hymenium hyaline; epihymenium brown, K–, hypothecium and margin brown, K–. On thallus of *Dermatocarpon pellitum*. See Keissler (1930). Distribution: 35 (Hafellner & John 2006)
.... ***Opegrapha pulvinata*** Rehm 1869

8(5). Ascomata arthonioid. Ascospores hyaline 9

8. Ascomata not arthonioid. Ascospores hyaline or brown (*Phacopsis*, *Nesolechia* and *Abrothallus* species are also keyed out here) 16

9(8). Ascospores mainly more than 1-septate 10

9. Ascospores mainly 1-septate 12

10(9). Ascomata distinct. Ascospores mainly 3-septate, on apothecia of *Lecanora* ... 11

10. Ascomata indistinct, developed between the asci and interascal filaments of the host. Interascal filaments with olivaceous brown pigmented apical caps. Ascospores mainly 2-, rarely 3-septate, 12–16 × 4 µm. In the apothecia of *Protoparmeliopsis muralis*. See Almquist (1880), Hertel (1969), Triebel (1989), and Coppins (1992). Distribution: 51(Halıcı et al 2007c) .... ***Arthonia intexta** Almq. 1880

11(10). Ascospores rarely 2-, mainly 3-septate; 13–18 × 5 µm. On apothecia of *Lecanora bicincta*, *L. rupicola* and *L. sulphurata*. See Hawksworth (1983) and Coppins (1992). Distribution: 11 (Hezarfen et al 2001), 16 (Yazıcı & Aslan 2006), 35 (John 1999), 38 (Halıcı et al 2005b), 61 (Etayo & Breuss 1998, John & Breuss 2004), 66 (Halıcı et al 2007f) .... ***Arthonia varians** (Davies) Nyl. 1861

11. Ascospores 3-septate; 15–16.5 × 5–7 µm. On apothecia of *Lecanora carpinea*. See Hawksworth (1985). Distribution: 35 (Hafellner & John 2006) .... ***Arthonia subfuscicola*** (Linds.) Triebel 1991

12(9). Ascospores mainly (12–)14–17 × (4–)5–6 µm, 1-, rarely 2-septate. Hymenium pale brown, I + purple, K/I + blue, hypothecium deep brown, K/I and I ± blue. On apothecia and thallus of *Sphaerothallia desertorum* group. See Calatayud et al. (2004). Distribution: 04, 38 (Hafellner & John 2006), 44 (unpubl.) .... ***Arthonia hertelii** (Calat., Barreno & V.J.Rico) Hafellner & V.John 2006

12. Ascospores less than 14 µm in length 13

13(12). Hymenium I + blue. On apothecia of *Rhizoplaca chrysoleuca*. Hypothecium hyaline or sometimes light brown. Ascospores 11–14 × 3.5–4(–5) µm. See Triebel (1989). Distribution: 61 (Etayo & Breuss 1998, John 1999, John & Breuss 2004) .... ***Arthonia clemens*** (Tul.) Th. Fr. 1867

13. Hymenium I + reddish brown or red 14

14(13). Hymenium brown, I + reddish brown. On thallus of *Lepraria caesioalba*. Ascospores 12–14 × 5 µm. Hypothecium brown. See Almquist (1880). Distribution: 45 (unpubl.) .... ***Arthonia excentrica** Th.Fr. 1867

14. Hymenium hyaline, I + red 15

15(14). Epihymenium almost blackened. Ascospores 11–13 × 4–5 µm. Hymenium hyaline, I + wine red. Hypothecium hyaline. On thallus and apothecia of *Caloplaca* sp., *C. biatorina*, *C. decipiens*, *C. lobulata*, *C. saxicola*, *C. trachyphylla* and *Xanthoria elegans*. Distribution: 02, 38, 42, 43 (Hafellner & John 2006), 44 (Halıcı & Candan 2007), 51, 66 (Halıcı et al. 2007c) .... ***Arthonia molendoi** (Heufl. ex Frauenf.) R.Sant. 1986

15. Epihymenium pale olive brown 16

16(15). Ascomata arise superficially on the host thallus; disc convex. Ascospores 9–12 × 3–4 µm. Hypothecium dark brown, hymenium I+ red. On thallus of *Physcia semipinnata*. See Santesson (1960), Vězda (1970), Alstrup (1981) and Coppins (1992). Distribution: 35 (Hafellner & John 2006)
.... **Arthonia epiphyscia** Nyl. 1875

16. Ascomata breaking through the cortex of the host thallus. Ascospores 10–13 × 4–5 µm. Hypothecium brownish, hymenium I + red. On thallus of *Physcia semipinnata* and *Phaeophyscia orbicularis*. See Grube & Matzer (1997). Distribution: 45 (Halıcı et al 2007d)
.... ***Arthonia phaeophysciae** Grube & Matzer 1997

17(8). Ascospores hyaline at maturity 18

17. Ascospores brown at maturity 32

18(17). Ascospores septate 19

18. Ascospores simple 23

19(18). Ascomata multilocular; hymenia separated by sterile stromatic tissue 20

19. Ascomata not multilocular 21

20(19). Ascomata forming distinct galls, black, with a thalline margin formed of host tissue and a constricted base; asci 4-8-spored, ascospores 16–25 × 4–9 µm, 3–septate. On thallus of *Lobaria pulmonaria*. See Diederich & Etayo (1994). Distribution: 14 (Halıcı & Cansaran-Duman 2007), 53 (John 1999), 67 (Hafellner & John 2006)
.... ***Plectocarpon lichenum** (Sommerf.) D.Hawksw. 1984

20. Ascomata not forming galls, reddish brown, up to 12–locular with distinct radiating lines of sterile tissue seperating the locules visible on the ascomata surface; asci (4-)6-8-spored; ascospores 16–25 × 6–8 µm, (1-)3-septate. On thallus of *Lobaria scrobiculata*. See Diederich & Etayo (1994). Distribution: 53 (Hafellner & John 2006)
.... **Plectocarpon scrobiculatae** Diederich & Etayo 1994

21(19). Ascospores (1-)3-(5-)-septate, 18.5–29 × 3–4.5 µm, epihymenium dark olivaceous green to bright green, K–, N + violet, lacking crystals. On thallus of *Degelia plumbea*. See Timdal (1991). Distribution: 31 (Hafellner & John 2006)
.... **Toninia plumbina** (Anzi) Hafellner & Timdal 1991

21. Ascospores constantly 1-septate and less than 15 µm in length 22

22(20). Epihymenium olivaceous green, K–, N + violet. Ascospores 11–14 × 4–5 µm. On thallus of *Aspicilia coronata* and *A. contorta* subsp. *hoffmanniana*. See Timdal (1991). Distribution: 51 (Halıcı et al. 2007g)
.... ***Toninia episema** (Nyl.) Timdal 1991

22. Epihymenium green to dark green, N + red. Ascospores 10–15 × 4–5 µm. On thallus of *Protoparmeliopsis muralis* and an unidentified crustose lichen. See Timdal (1991). Distribution: 45 (Halıcı & Candan 2007), 61 (John & Breuss 2004) .... ***Toninia subfuscae** (Arnold) Timdal 1991

23(18). Ascomata with a reduced or indistinct exciple at maturity **23**

23. Ascomata with a distinct exciple **26**

24(23). Ascospores 13–18(–21) × 5–7 µm. Ascomata reddish brown. On thallus of *Parmelia saxatilis, P. submontana, Parmelina tiliacea, Xanthoparmelia verruculifera, X. conspersa* and *X. tinctina*. See Triebel & Rambold (1988), Triebel et al. (1995), Diederich (2003), and Doré et al. (2006). Distribution: 35, 45 (John 1999), 48 (Hafellner & John 2006)
.... ***Nesolechia oxyspora*** (Tul.) A.Massal. 1856

[**Note**: Hafellner & John (2006) also reported *Nesolechia oxyspora* var. *fusca* on *Xanthoparmelia conspersa* and *X. tinctina*. The two varieties, var. *oxyspora* and var. *fusca* were stated to differ from each other by the colour and I reaction of hypothecium and the host selections (Triebel & Rambold 1988). However Doré et al. (2006) reported that the intensity of the colour of hypothecium was related to the thickness of the sections, and the I reaction of the hypothecium is of a low taxonomic value as stated by Diederich (2003). In view of these observations, reports of var. *fusca* are treated under the name *N. oxyspora* here.]

24. Ascospores < 16 µm in length **25**

25(24). Ascospores 13–16 × 5–7 µm. Hypothecium colourless, I + violet. On thallus of *Letharia vulpina*. See Hafellner (1987a) and Triebel et al. (1995). Distribution: 38 (Halıcı et al. 2007c) .... ****Phacopsis vulpina*** Tul. 1852

25. Ascospores 9–11(–12) × 5–7 µm. Hypothecium colourless to pale brown, I –. On thallus of *Hypogymnia laminisorediata*. See Triebel & Rambold (1988) and Triebel et al. (1995). Distribution: 45 (Hafellner & John 2006)
.... ***Phacopsis cephalodioides*** (Nyl.) Triebel & Rambold 1988

26(23). Epihymenium blue-green **27**

26. Epihymenium not blue-green **30**

27(26). Ascospores with rounded apices **28**

27. Ascospores with attenuated apices, 12–14 × 6–8 µm. Hypothecium hyaline, ascomata in sections with bright blue to green pigment. On thallus of *Aspicilia contorta* subsp. *hoffmanniana*. See Hertel (1983) and Galloway & James (1992). Distribution: 26 (unpubl.)
............................****Carbonea supersparsa*** (Nyl.) Hertel 1983

28(27). Apothecial disc flat, margin distinct. Hymenium hyaline or aeruginose **29**

28. Apothecial disc convex, margin present but indistinct. Hymenium always hyaline. Hypothecium brown K –. Ascospores 9–13 × 4–5 µm. On thallus of *Lecanora dispersoareolata*. See Diederich (2003). Distribution: 04 (Hafellner & John 2006)
............***Carbonea aggregantula*** (Müll.Arg.) Diederich & Triebel 1993

29(28). Thallus absent. Hymenium hyaline, hypothecium brown, K –. Ascospores 7–11 × 5–7 µm. On thallus of *Candelariella vitellina* and *C. coralliza*. See Hertel (1983). Distribution: 04 (Hafellner & John 2006), 14 (Halıcı & Cansaran-Duman 2007), 16 (Güvenç & Öztürk 2004), 26 (Özdemir Türk 2002), 29, 53, 61 (John & Breuss 2004), 38 (Steiner 1905; Halıcı et al. 2005b)
.... ****Carbonea vitellinaria*** (Nyl.) Hertel 1983

29. Thallus present, dark olive-grey. Hypothecium K + violet. Ascospores 11–15 × 5 µm, on thallus of *Rhizocarpon geographicum*. See Wirth (1995) and Hafellner (2004). Distribution: 01 (Halıcı et al. 2007g) .... ***Scoliciosporum intrusum** (Th.Fr.) Hafellner 2004

30(26). Ascomatal margin sometimes with short hairs. Ascomata at first perithecioid, then apothecioid when mature. Ascospores 11–12 × 4–5 µm. On thallus of *Rhizocarpon* sp. See Triebel (1989) and Diederich & Etayo (2000). Distribution: 35 (Hafellner & John 2006) .... **Rhymbocarpus geographici** (J.Steiner) Vouaux 1913

30. Ascomatal margin never with short hairs 31

31(30). Ascospores 9–10 × 3 µm, consistently 2-guttulate. Exciple purplish; hypothecium reddish. On apothecia of *Caloplaca lactea*. See Alstrup & Hawksworth (1990) and Diederich & Etayo (2000). Distribution: 01 (Halıcı et al. 2007g) .... ***Unguiculariopsis groenlandiae** (Alstrup & D.Hawksw.) Etayo & Diederich 1998

31. Ascospores (7–)9–11 × 5–7 µm: Exciple purple-brown to dark red-brown; epihymenium red brown. On thallus of *Acarospora nodulosa* var. *reagens*. See Hafellner & Navarro-Rosinés (1993). Distribution: 58 (Hafellner & John 2006).......... ***Llimoniella scabridula** (Müll.Arg.) Nav.-Ros. & Hafellner 1993

32(17). Ascomata without exciple and disc usually strongly convex 33

32. Ascomata with exciple, disc not strongly convex 37

33(32). Vegetative hyphae I + blue, ascospores 10–17 × 4–7 µm, on thallus of *Melanelixia fuliginosa*. See Hawksworth (1983). Distribution: 61 (John & Breuss 2004) .... **Abrothallus bertianus** De Not. 1849

34. Vegetative hyphae I – 34

34(33). On *Usnea* sp. (on basidiomata of *Biatoropsis usnearum*). Ascospores 14–18 × 5–7 µm. See Diederich & Christiansen (1994). Distribution: 61 (Etayo & Breuss 1998; John & Breuss 2004) .... **Abrothallus usneae** Rabenh. 1861

34. Not on *Usnea* sp 35

35(34). Distinctly gall inducing, ascospores 12–17(–20) × 4–7(–8) µm, on thallus of *Parmelia saxatilis*. See Kotte (1909). Distribution: 35 (John 1996) .... **Abrothallus parmeliarum** (Sommerf.) Arnold 1874

35. Not gall inducing 36

36(35). Ascomata sessile to often short-stalked; ascospores 10–17 × 5–7 µm. On thallus of *Hypogymnia physodes*. See Diederich (1990). Distribution: 69 (Yazıcı & Aslan 2007) ...... **Abrothallus prodiens** (Harm.) Diederich & Hafellner 1989

36. Ascomata sessile, not stipitate, ascospores 13–15 × 6.5–7.5 µm. *Vouauxiomyces* anamorph with conidia 12.5–17 × (4–)4.5–5(5.5–) µm. On thallus of *Xanthoparmelia stenophylla*. See Cole & Hawksworth (2001). Distribution: 14 (unpubl.) .... ***Abrothallus tulasnei** M.S:Cole & D. Hawksw. 2001

37(32). Exciple reddish brown, ascospores 12–14 × 4.5–6 5 µm, wall slightly warted. On thallus of *Lobaria pulmonaria*. See Hafellner (1979). Distribution: 67 (Hafellner & John 2006) .... **Dactylospora lobariella** (Nyl.) Hafellner 1979

37. Exciple brown, ascospore wall smooth 38

38(37). Ascospores 8–11 × 4.5–5 µm. On thallus of *Aspicilia contorta* subsp. *hoffmanniana*. See Hafellner (1979). Distribution: 42 (Halıcı et al. 2007g)
.... ***Dactylospora homoclinella*** (Nyl.) Hafellner 1979

38. Ascospores 9–15 × 4.5–7.5 µm. On thallus of *Pertusaria* sp. See Hafellner (1979). Distribution: 67 (John 2000)
.... ***Dactylospora saxatilis*** (Schaer.) Hafellner 1979

39(2). Ascospores hyaline at maturity 40

39. Ascospores brown at maturity 55

40(39). Ascospores simple 41

40. Ascospores transversely septate 42

41(40). Not forming galls. Ascomata black, ~ 0.2 mm diam., ostiole broad and urceolate, greenish. Hamathecium of branched and anastomosed interascal filaments. Ascospores tear-like, with many oil droplets, uniserially arranged in asci, 14–15× 6–7 µm. On thallus of *Aspicilia contorta* and *Lobothallia radiosa*. See Etayo (1994). Distribution: 14 (Halıcı & Cansaran-Duman 2007), 45 (Halıcı et al. 2007e)
.... ***Zwackhiomyces lecanorae*** (Stein) Nik.Hoffm. & Hafellner 2000

41. Fungus gall-inducing. Ascomata immersed in irregular warts , visible as small black dots, 130–230× 120–230 µm. Interascal filaments not present in the mature ascomata. Ascospores 15–24× 4–8 µm. On thallus of *Xanthoria parietina*. See Hawksworth (1975) and Hoffman & Hafellner (2000). Distribution: 70 (Hafellner & John 2006)
.... ***Telogalla olivieri*** (Vouaux) Nik.Hoffm. & Hafellner 2000

42(40). Ascospores (1-)3-septate, not constricted at the septum, the cells often with conspicuous rounded vacuoles, smooth walled, lacking a defined gelatinous sheath, 12–21× 4.5–7 µm. Interascal filaments present. On thalli of *Sphaerothallia desertorum*. Distribution: 38 (Halıcı et al. 2006), 44 (unpubl.)
.... ***Sagediopsis desertorum*** Halici, D.Hawksw., A.O.Türk & Candan, ined.

42. Ascospores 1-septate 43

43(42). Ascomata red-brown where protruding; ascospores subglobose, 9–11× (4–)6–8 µm. On apothecia of *Physcia semipinnata*. See Lowen (1989)and Diederich (2003). Distribution: 34 (Steiner 1899)
.... ***Pronectria leptaleae*** (J.Steiner) Lowen 1990

43. Ascomata black 44

44(43). Ascomata setose, dispersed over the surface of the host, arising from a superficial dark brown to black reticulate mycelium, ascospores 8–9.5× 3.5–4.5 µm, apices rounded. On thalli of *Hypogymnia tubulosa*. See Zopf (1898) and Keissler (1930). Distribution: 38 (Halıcı et al. 2007c)
.... ***Echinothecium reticulatum*** Zopf 1898

44. Ascomata never setose 45

45(44). Interascal filaments absent or indistinct. Periphyses or periphysoids present 46

45. Interascal filaments present 47

46(45). (a) On thallus of *Umbilicaria* sp. and *Umbilicaria leiocarpa*. Few superficial brownish vegetative hyphae present. Ascomata black, semi-immersed, ~ 80 µm. Ascospores colourless, 1-septate, with 1 oil droplet per cell, 15–20 × 7–9 µm. See Hawksworh & Diederich (1988), Roux & Triebel (1994) and Triebel & Cáceres (2004). Distribution: 26, 38 (Halıcı et al. 2007e) .... ****Stigmidium gyrophorarum*** (Arnold) D.Hawksw. 1975

46. (b) On thallus of *Physcia* sp. Ascospores 8–15 × 3–7 µm. See Matzer & Hafellner (1990). Distribution: 38 (Hafellner & John 2006) .... ***Stigmidium pumilum*** (Lettau) Matzer & Hafellner 1990

46. (c) On thallus of *Xanthoparmelia* sp. Distribution: 35 (Hafellner & John 2006) .... ***Stigmidium xanthoparmeliarum*** Hafellner 1994

46. (d) On thallus of *Psora decipiens*. Ascomata globose, 125–150 µm diam., erumpent. Hymenial gelatine I –, asci Lugol's I + red (without pre-treatment with K), 8-spored, 49–52 × 19–20 µm. Ascospores 15–16 × 5–6 µm. See Triebel (1989) and Calatayud & Triebel (1999). Distribution: 06 (Halıcı et al. 2007d) .... ****Stigmidium psorae*** (Anzi) Hafellner 1984

46. (e) On thallus of *Toninia* sp. and *T. sedifolia*. Ascomata 65 × 75 µm diam. Ascospores 10–16 × 3 µm. See Triebel (1989). Distribution: 23, 45 (Halıcı et al. 2007d), 38 (Hafellner & John 2006) .... ****Stigmidium tabacinae*** (Arnold) Triebel 1989

46. (f) On thallus of a lobate *Caloplaca* sp. Ascomata 50-60 µm diam. Ascospores overlapping and distichously arranged in the asci, elongate-ellipsoid with somewhat attenuated apices (appearing more rounded ın KOH), hyaline, 1-septate, not or scarely constricted at the septum, the cells almost equal in size, smooth-walled, without an evident gelatinous perispore, (12.5–)13–16.5 × 5–6.5 µm. See Halıcı & Hawksorth (2007). Distribution: 38 (Halıcı & Hawkworth 2007) .... ****Stigmidium johnii*** Halici & D.Hawksw. 2007

46. (g) On apothecia of *Caloplaca cerina* var. *muscorum*. Ascomata 50–70 µm diam. Ascospores 10–13 × 3–4 µm. See Roux & Triebel (1994) and Roux et al. (1995). Distribution: 38 (Halıcı et al. 2007c) .... ****Stigmidium cerinae*** Cl.Roux & Triebel 1994

46. (h) On thallus of *Pertusaria lactea*. Ascospores 12.5–18 × 2.5–5 µm. Distribution: 61 (Hafellner & John 2006) .... ***Stigmidium eucline*** (Nyl.) Vězda 1970

46. (i) On apothecia of *Lecanora chlarotera*. Ascospores (11–)12–14(–16) × 2.5(3–)–4 µm, epispore finally verruculose. See Triebel (1989) and Roux & Triebel (1994). Distribution: 35 (Hafellner & John 2006) .... ***Stigmidium congestum*** (Körb.) Triebel 1991

46. (j) On apothecia of *Protoparmeliopsis muralis*. Ascospores 9–13 × 4–5 µm. See Roux & Triebel (1994). Distribution: 38, 51 (Hafellner & John 2006) .... ***Stigmidium squamariae*** (de Lesd.) Cl.Roux & Triebel 1994

47(45). Ascomatal wall with brown pigment as fine granules and ascospores with indistinct or warty halo 48

47. Ascomatal wall with blue to green, rarely brown pigment, the pigment amorphous and young ascospores halonate 50

48(47). Ascospores smooth, 15–20 × 5–7.5 µm, ascomatal wall dark brown pigmented, pigment on the wall cells and the intercellular areas. On thallus of *Lobothallia radiosa*. See Grube & Hafellner (1990).Distribution: 27 (Hafellner & John 2006) .... **Zwackhiomyces lithoiceae** (de Lesd.) Hafellner & V.John 2006

48. Ascospores with a verruculose wall **49**

49(48). Ascomata globose to pyriform, 150–250 µm, ascomatal wall homogenously pigmented. Ascospores with a finely verruculose epispore, 15–21 × 5–9 µm; ± unequal celled. Asci (4–)6(–8) –spored. On apothecia and thallus of *Caloplaca* sp., *C. erodens*, *C. flavovirescens*, *C. lactea*, *Xanthoria elegans*. See Grube & Hafellner (1990). Distribution: 14 (Halıcı & Cansaran-Duman 2007), 38 (Hafellner & John 2006; Halıcı et al. 2007c), 51, 66 (Halıcı et al. 2007c), 44, 58 (unpubl.)
.... ***Zwackhiomyces coepulonus** (Norman) Grube & R.Sant. 1990

49. Ascomata pyriform, 150–250 µm; ascomatal wall not homogenously pigmented, brown with basal cells paler than the upper ones. Asci (4-)6(-8)-spored. Ascospores verruculose, 18–25 × 5–9 µm. On apothecia of *Caloplaca* sp., *C. variabilis* and *Xanthoria elegans*. See Grube & Hafellner (1990). Distribution: 02, 23 (Halıcı & Candan 2007), 38 (Halıcı et al. 2006)
.... ***Zwackhiomyces sphinctrinoides** (Zwackh) Grube & Hafellner 1990

50(47). Ascospores soleiform, almost uniseriate but overlapping in asci, hyaline, 1-septate, the septum in the lower quarter of the spore, not or slightly constricted at the septum, smooth-walled, 17–23 × 6–8µm. Ascomata subglobose, almost completely immersed in the host thallus, 150–200 µm diam; ostiolate; exciple composed of pseudoparenchymatous cells, brown, the region around the ostiole K + aeruginose green. On a sterile grey crustose lichen (possibly *Aspicilia* sp.). See Calatayud (1998). Distribution: 42 (Halıcı et al. 2007c)
.... ***Cercidospora solearispora** Nav.-Ros., Calat. & Hafellner, ined.

50. Ascospores not soleiform 51

51(50). Ascospores with the lower cell elongated and curved, 24–28 × 6–7 µm. On thallus and apothecia of *Caloplaca aurantia*, *C. chalybaea* and *C. flavescens*. See Hafellner (1987). Distribution: 38, 51 (Halıcı et al. 2007g)
.... ***Cercidospora caudata** Kernst. 1895

51. Ascospores not with the lower cell elongated and curved 52

52(51). Ascospores 10–12 × 5–6 µm. Asci 4-spored. On apothecia of *Caloplaca biatorina* and *Xanthoria elegans*. See Weddell (1874) and Hafellner & John (2006). Distribution: 38, 58 (Hafellner & John 2006)
.... **Cercidospora xanthoriae** (Wedd.) R.Sant. 1993

52. Ascospores longer in length 53

53(52). Ascospores 20–26 × 5–7.5 µm. Asci (4-)6(-8)-spored. Ascomatal wall blue-green. On apothecia and thallus of *Protoparmeliopsis muralis* and *Rhizoplaca melanophtalma*. See Hafellner (1987). Distribution: 04 (Hafellner & John 2006), 38 (Halıcı et al. 2005b), 51 (Halıcı et al. 2007c)
.... ***Cercidospora macrospora** (Uloth) Hafellner & Nav.-Ros. 2004
[Syn. *Cercidospora ulothii* Körb. 1865]

53. Ascospores mainly shorter than 20 µm 54

54(53). Ascomatal wall almost hyaline, olivaceous near the ostiole, aeruginose in K; ascospores 14–18 × 4–6 µm. Asci (4-)6(-8) -spored. On the thallus of *Lecanora polytropa*. See Hafellner (1987). Distribution: 38 (Steiner 1905; Halıcı et al. 2005b; Halıcı et al. 2007c) .... ***Cercidospora epipolytropa*** (Mudd) Arnold 1874

54. Ascomatal wall blue-green. Perithecia immersed, 150–180 µm diam. Asci 8-spored. Ascospores 16.5–20 × 4.5–6 µm. On apothecia of *Caloplaca* sp. See Grube & Hafellner (1990). Distribution: 38 (Halıcı et al. 2006) .... ***Cercidospora epicarphinea*** (Nyl.) Grube & Hafellner 1990

55(39). Ascospores simple 56

55. Ascospores transversely septate or muriform 58

56(55). Asci 4-spored, ascospores simple, sometimes 1-septate (up to 2-septate ascospores can also be found), 35–50 × 12–15 µm. On squamules of *Cladonia pyxidata*. See Matzer & Hafellner (1990) and Matzer & Pelzmann (1991). Distribution: 45 (unpubl.) .... ***Roselliniella cladoniae*** (Anzi) Matzer & Hafellner 1990

56. Asci multi-spored 57

57(56). Asci to 50-spored, ascospores 7–8 × 4–5 µm. Immersed in thallus areoles of *Aspicilia intermutans*. See Hafellner (1985). Distribution: 44 (Halıcı & Candan 2007)........ ***Rosellinula haplospora*** (Th.Fr. & Almqu. ex Th.Fr.) R.Sant. 1986

57. Asci to 100-spored, ascospores 5–7 × 5–6 µm. On thallus and apothecia of *Lecanora frustulosa*, where bleaching is seen in the infected areoles of the thallus. See Hafellner (1985). Distribution: 66 (Halıcı et al. 2007f) .... ***Rosellinula frustulosae*** (Vouaux) R.Sant. 1988

58(55). Ascospores 1-septate 59

58. Ascospores more than 1-septate or muriform 88

59(58). Ascomata internal structure paraplectenchymatic stromatic 60

59. Ascomata internal structure not paraplectenchymatic stromatic 64

60(59). Ascospores (1-)3-transseptate, sometimes with an oblique longiseptum in one or two cells, strongly constricted at the medium septum, (12–)13–16.5 × 6.5–10 µm. Superficial hyphal strands are absent to poorly developed. On thallus of *Aspicilia* sp. and *Aspicilia caesiocinerea*. See Halıcı & Hawksworth (2007). Distribution: 38, 42 (Halıcı & Hawksworth 2007) .... ***Lichenostigma triseptatum*** Halici & D.Hawksw. 2007

60. Ascospores constantly 1-transseptate 61

61(60). Ascomata connected to each other by superficial strands of dark brown to black hyphae 62

61. Ascomata not connected to each other by superficial strands of dark brown to black hyphae 63

62(61). Ascomata not distinctly elongated. Central part of ascomata I + reddish. Ascospores 8–12 × 4–5 µm. On thallus of *Xanthoparmelia* sp., *X. stenophylla* and *X. tinctina*. See Hafellner & Calatayud (1999) and Calatayud et al. (2002). Distribution: 14 (Halıcı & Cansaran-Duman 2007), 35 (Hafellner & John 2006) .... ***Lichenostigma cosmopolites*** Hafellner & Calat. 1999

62. Ascomata distinctly elongated. Central part of ascomata I–. Ascospores 9–13 × 6–8.5 µm. On thallus of *Aspicilia* sp. and *Lobothallia radiosa*. See Navarro-Rosinés & Hafellner (1996) and Calatayud et al. (2002). Distribution: 04, 35, 38, 43 (Hafellner & John 2006)
.... ***Lichenostigma elongatum*** Nav.-Ros. & Hafellner 1996

63(61). Ascomata not aggregated. Ascospores echinulate, upper cell wider; 9–12 × 4–6 µm. On thallus of *Hypogymnia tubulosa*, *Pseudevernia furfuracea* and *Usnea subfloridana*. See Hafellner (1982). Distribution: 14 (Halıcı & Cansaran-Duman 2007), 16 (Hafellner 1982), 35, 45 (Hafellner & John 2006), 17, 26 (Halıcı & Candan 2007), 42, 66 (Halıcı et al. 2006)
.... ***Lichenostigma maureri*** Hafellner 1982

63. Ascomata frequently aggregated. Ascospores dark brown when mature, echinulate, upper cell wider; 10–12 × 5–6 µm. On thallus of *Diploschistes scruposus*. See Thor (1985). Distribution: 38 (unpubl.)
.... ***Lichenostigma rugosum*** G.Thor 1985

64(59). Asci 16-100 spored **65**

64. Asci 2-8 spored **68**

65(64). Ascomata > 150 µm. Asci < 64-spored. Ascospores 4–6 µm wide **66**

65. Ascomata < 150 µm. Asci > 64-spored. Ascospores 4.5–6 × 2.5–4 µm. On thallus of *Aspicilia* sp., *A. calcarea* and *Lecidea confluens*. See Hawksworth (1979b) and Triebel (1989). Distribution: 38, 51 (Halıcı et al. 2007c)
.... ***Muellerella lichenicola*** (Sommerf.) D.Hawksw. 1979

66(65). Ascospores smooth-walled **67**

66. Ascospores slightly verruculose and ellipsoid to narrowly ellipsoid, 7–12 × 4–6 µm. On thallus of *Acarospora* sp., *A. fuscata*, *Aspicilia* sp., *A. caesiocinerea*, *A. calcarea*, *A. contorta*, *Caloplaca* sp., *C. flavovirescens*, *C. trachyphylla*, *Lecanora* sp., *L. dispersoareolata*, *L. garovaglii*, *L. polytropa*, *Lecidea* sp., *Lobothallia radiosa*, *Rhizocarpon geographicum*, *Rhizoplaca peltata* and *Xanthoria elegans*. See Hawksworth (1979b) and Triebel (1989). Distribution: 69 (Yazıcı & Aslan 2007), 23, 44, 45 (Halıcı & Candan 2007), 38 (Steiner 1905; Halıcı et al. 2005b, Hafellner & John 2006), 51 (Halıcı et al. 2007c), 35, 61 (Hafellner & John 2006)....................... ***Muellerella pygmaea*** (Körb.) D.Hawksw. 1979

[**Note:** This species was reported as a new record to Turkey by Yazıcı & Aslan (2007) although it was first recorded by Steiner (1905)]

67(66). Ascomata < 200 µm. Ascospores ± pale brown, 6–8 × 3–4.5 µm. On thallus of *Aspicilia calcarea*, *Caloplaca* subgen. *Pyrenodesmia* sp., *Clauzadea monticola*, *Lecanora polytropa*, *Lecidella stigmatea*. See Triebel (1989) and Hafellner & John (2006). Distribution: 38 (Steiner 1905; Halıcı et al. 2005b), 35, 58, 65 (Hafellner & John 2006)
.... ***Muellerella erratica*** (A.Massal.) Hafellner & V.John 2006
[Syn. *Muellerella pygmaea* var. *athallina* (Müll.Arg.) Triebel 1989]

67. Ascomata > 200 µm. Ascospores dark brown, thick-walled, 7–8.5 × 4.5–5.5 µm, on thallus of *Rhizocarpon geographicum*. See Triebel (1989). Distribution: 51 (unpubl.) .... ***Muellerella ventosicola*** (Mudd) D.Hawksw. 2003

68(64). Interascal filaments present, branched and anastomosing (paraphysoids or pseudoparaphyses) 69

68. Interascal filaments absent (periphyses sometimes present) 76

69(68). Ascomata arising in groups united by a dark clypeus; walls consisting of compacted interwoven hyphae. Ascospores pale brown, 13–14 × 6 µm. On thallus of *Hypocenomyce scalaris*. See Hawksworth (1980) and Triebel (1989). Distribution: 26 (Halıcı & Candan 2007), 35 (Hafellner & John 2006) .... ****Clypeococcum hypocenomycis*** D.Hawksw. 1980

69. Ascomata arising singly, not united by a clypeus; wall consisting of angular pseudoparenchymatous cells 70

70(69). Ascospores less than 20 µm in length 71

70. Ascospores exceeding 20 µm in length 72

71(70). Ascospores (11–)13.5–15(–16) × 6.5–7.5 µm, distichously arranged in the asci, ellipsoid, brown, smooth walled, (0-)1-septate, somewhat constricted at the septum, both cells ± equal in size, the lower cell somewhat attenuated, with a thin colourless gelatinous sheath 0.5 µm thick. Asci 8-spored. On thallus of *Aspicilia cinerea*. See Halıcı et al. (2007b). Distribution: 38 (Halıcı et al. 2007b) ....****Polycoccum aksoyi*** Halici & V.Atienza 2007

71. Ascospores 13–14 × 6 µm, verruculose. Asci 8-spored. On thallus of *Acarospora* sp. See Hawksworth & Diederich (1988) and Atienza et al. (2004). Distribution: 38 (Halıcı et al. 2007c) .... ****Polycoccum microstictum*** (Mudd) Arnold 1891

72(70). Asci 2-spored. Ascospores ellipsoid, cells ± equal in size, verruculose, 25–28 × 8 – 11 µm. On thallus of *Verrucaria calciseda*. See Hawksworth & Diederich (1988). Distribution: 45 (Halıcı et al. 2007e) .... ****Polycoccum dzieduszyckii*** (Boberski) D.Hawksw. 1980

72. Asci 4-6- or 8-spored 73

73(72). Asci 4-spored. Ascospores ± uniseriately arranged, cells ± equal in size, 25–30 × 8–10 µm. 1-2 guttules are often present in the ascospores. On thallus of *Peltigera* sp. See Hawksworth & Diederich (1988). Distribution: 44 (Halıcı et al. 2007d) .... ****Polycoccum crassum*** Vězda 1970

73. Asci 4-6- or 8-spored 74

74(73). Asci 4-6-8 spored. Ascospores 24–27 × 10–13 µm, the lower cell larger. On endolithic *Verrucaria* sp. . See Hawksworth & Diederich (1988). Distribution: 38 (Halıcı et al. 2007g) .... ****Polycoccum marmoratum*** (Kremp.) D.Hawksw. 1980

74. Asci constantly 8-spored 75

75(74). Ascospores (25–)28.5–31.5(–34) × (7–)8–9.5 µm, distichously arranged in the asci, ellipsoid, hyaline for a long time and brown when mature, verruculose, somewhat constricted at the septum, cells ± equal in size, both ends rounded, especially in some young ascospores, 2-5 guttulate, without a gelatinous sheath. On thallus of *Acarospora cervina*. See Halıcı et al. (2007b). Distribution: 38, 44 (Halıcı et al. 2007b) .... ****Polycoccum acarosporicola*** Halici & D.Hawksw. 2007

75. Ascospores 22–23 × 10 µm, distichously arranged, broadly ellipsoid, upper cell often slightly broader and rounded, the lower often attenuated, olivaceous brown at maturity. On thalli of *Sporastatia testudinea*. See Hawksworth & Diederich (1988). Distribution: 26 (Halıcı et al. 2007e) .... ***Polycoccum sporastatiae*** (Anzi) Arnold 1874

76(68). Forming brown vegetative hyphae in the host tissue. Ascospores hyaline or brown **77**

76. Not forming brown vegetative hyphae in the host tissue. Ascospores brown .. **78**

77(76). Ascomata never arising from black and necrotic areas of the host thallus, mycelium dark brown, superficial or semi-immersed. Ascospores usually hyaline, rarely becoming pale olive greyish or yellowish brown with age, soleiform or lecythiform, halonate, (7–)9–12.5(–14) × (2.5–)3–4.5(–5) µm. On squamules of *Cladonia pyxidata*. See Zhurbenko & Alstrup (2004). Distribution: 35 (Hafellner & John 2006) .... ***Sphaerellothecium cladoniae*** (Alstrup & Zhurb.) Hafellner 2005

77. Ascomata arising from black and necrotic areas of the host thallus, usually connected to a network of brown, superficial and vegetative hyphae. Ascospores not halonate, hyaline, rarely becoming brownish at maturity, 8.5–10 × 3–4 µm. On thallus of *Parmelia saxatilis*. See Etayo & Diederich (1998). Distribution: 16 (Hafellner & John 2006) .... ***Sphaerellothecium parmeliae*** Diederich & Etayo 1998

78(76). Asci unitunicate, apically not or slightly thickened, 8-spored. Ascospores dark brown, thin walled, smooth, 13–18(–20) × 7–8(–9.5) µm. On thallus of *Dermatocarpon biennense*. See Etayo & Breuss (1998). Distribution: 61 (Etayo & Breuss 1998; John & Breuss 2004) .... ***Adelococcus immersus*** Etayo & Breuss 1998

78. Asci bitunicate, with distinct apical thickenings **79**

79(78). Exciple two-layered, with a thick colourless outer layer, composed of numerous layers of cells, the inner layer red brown to dark brown. Ascospores irregularly arranged in the ascus, generally overlapping but sometimes almost uniseriate in part, at first globose but becoming subglobose to broadly ellipsoid as they mature, red-brown, (0)-1 distoseptate, septum central and cells equal in size, not constricted at the septum when mature, walls 2-layered, the outer dark brown and 1–1.5 µm thick and the inner paler brown and 0.5–1 µm thick, the thin septum internal to both wall layers, sometimes also with a large guttule in each cell, walls smooth, lacking an evident gelatinous sheath, spores 10–12 × (7.5–)8–9.5 µm. On thallus of *Aspicilia calcarea*. See Hawksworth & Halıcı (2007). Distribution: 38 (Halıcı & Hawksworth 2007) .... ***Gemmaspora lecanorae*** (Werner) D.Hawksw. & Halici 2007

79. Exciple not with a colourless outer layer. Ascospores not distoseptate **80**

80(79). Asci 4-spored. Ascospores distinctly verruculose, (11–)13–16(18) × (5.5–)6.5–7.5(–8.5) µm. On thallus of *Staurothele areolata*. See Halıcı et al. (2007a). Distribution: 38 (Halıcı et al. 2007a) .... ***Endococcus variabilis*** Halici, Kocourk. & Diederich 2007

80. Asci 8-spored **81**

81(80). Ascospores with both ends, or rarely only one end somewhat constricted, (12–)14–16(–20) × 4–6(–8) µm. On thallus of *Lecidella carpathica*. See Hawksworth (1979b). Distribution: 34 (Steiner 1899) .... **Endococcus stigma** (Körb.) Stizenb. 1882

81. Ascospores with both ends rounded 82

82(81). Ascospore walls distinctly verruculose, 11–15(–16) × 7 µm. On thallus of *Aspicilia* sp. See Hafellner (1994). Distribution: 44 (Halıcı & Candan 2007) .... ***Endococcus verrucosus** Hafellner 1994

82. Ascospore walls smooth 83

83(82). Ascospores less than 5 µm wide 84

83. Ascospores more than 5 µm wide 85

84(83). Ascospores 15–19 × 4–5 µm. On thallus of *Lecidella carpathica*. See Hawksworth (1979b), Triebel (1989) and Sérusiaux et al. (1999). Distribution: 45 (unpubl.) .... ***Endococcus exerrans** Nyl. 1879

84. Ascospores 8.5–13 × 3–3.5 µm, pale brown. On thallus of *Stereocaulon vesuvianum*. See Keissler (1930). Distribution: 45 (Halıcı et al. 2007e) .... ***Endococcus nanellus** Ohlert 1874

85(83). Ascospores 9–11 × 6–7 µm, spore wall with a smooth epispore. On thallus of a brown crustose lichen on calcareous rocks. See Hawksworth (1979b) and Rambold et al. (1990). Distribution: 02 (Halıcı et al. 2007e) .... ***Endococcus propinquus** (Körb.) D.Hawksw. 1979

85. Ascospores mainly exceeding 11 µm in length 86

86(85). Ascospores 18–24(–27) × 7–12(–14) µm. On thallus of *Rhizocarpon geographicum*. See Winter (1884-87), Zopf (1897) and Hafellner (1993). Distribution: 01, 40, 42 (Halıcı et al. 2007c); 38 (Steiner 1905; Halıcı et al. 2005b)........................ ***Endococcus macrosporus** (Arnold) Nyl. 1878

[Syn. *Endococcus perpusillus* Nyl. 1857]

86. Ascospores 6–7 µm wide 87

87(86). Ascospores with both ends rounded, not constricted at the septum, 11–15(–16) × 5–7 µm. On thallus of *Aspicilia* sp. and *Lecidea fuscoatra*. See Hawksworth (1979b), Alstrup & Hawksworth (1990) and Sérusiaux et al.(1999). Distribution: 38 (Halıcı et al. 2007c); 44 (Halıcı et al. 2007d) .... ***Endococcus rugulosus** Nyl. 1855

87. Ascospores with both ends rounded, slightly constricted at the septum, 13–15 × 5.5–6 µm. On thalli of *Collema* sp. See Vouaux (1912). Distribution: 51 (Halıcı et al. 2007g) .... ***Endococcus pseudocarpus** Nyl. 1873

88(58). Ascomata with smooth-walled but with non-septate or 1-3-septate unbranched dark brown setae arising from the upper part; setae smooth-walled, rounded at the apex and hardly attenuated,13–26 × 2–2.5 µm. Interascal filaments absent. Ascospores pale brown, 3-5-septate, constricted at the septa, some slightly curved; smooth-walled, (19–)22–25(–28) × 6.5–7 µm. On thallus of *Chromatochlamys muscorum*. See Halıcı et al. (2008). Distribution: 45 (Halıcı et al. 2008) ... ***Capronia minutosetosae** Halici, D.Hawksw., A.O.Türk & Candan, ined.

88. Ascomata not with setae 89

89(88). Ascomata not ostiolate, opening irregularly by fragmentation of cephalothecoid plates **90**

89. Ascomata ostiolate, opening regularly, no cephalothecoid plates formed in the upper part **92**

90(89). Asci 2-spored; ascospores verruculose, (2-)3-septate, (34–)50–61(–69) × (15–)18.5–21.5(–22) µm. On thallus of *Acarospora* sp. and *A. cervina*. See Halıcı et al. (2005a). Distribution: 38 (Halıcı et al. 2005a), 44 (Halıcı et al. 2007d) .... ***Weddellomyces turcicus** Halici & Orange 2005

90. Asci 4-8-spored **91**

91(90). Ascospores remain hyaline for a long time but pale brown when mature, 2-3(-4)-septate, 33–53.5 × 10–18(–20) µm. On thallus of *Aspicilia* sp. See Hawksworth (1990) and Navarro-Rosinés & Roux (1995). Distribution: 42 (Halıcı et al. 2007a); 16, 44 (unpubl.) .... ***Weddellomyces macrosporus** D.Hawksw., Renob. & Coppins 1990

91. Ascospores brown, 3-septate, the end cells always paler, 32–36(–40) × 11–13 µm. On thallus of *Aspicilia* sp. See Navarro-Rosinés & Roux (1995). Distribution: 70 (Halıcı et al. 2007e) .... ***Weddellomyces heterochrous** Nav.-Ros. & Cl.Roux 1995

92(89). Asci 16-spored, 3-septate, 13–15 × 5–7 µm. On thallus of *Lecidea fuscoatra*. See Hawksworth (1985). Distribution: 38 (Halıcı et al. 2007c) .... ***Muellerella vesicularia** (Linds.) D.Hawksw. 1985

92. Asci 4- or 8-spored **93**

93(92). Asci 4-spored. Ascospores 2(-3)-septate, 27–31 × 11–12 µm, the end cells are paler. Hamathecium of branched and anastomosing interascal filaments (pseudoparaphyses). On thallus of unidentified brown crustose lichen. See Hawksworth (1980, 1983). Distribution: 38 (Halıcı et al. 2007g) .... ***Pyrenidium actinellum** Nyl. 1865

93. Asci 8-spored **94**

94(93). Interascal filaments absent. Ascospores 3-septate, pale brown, constricted at the septa, 18–22 × 7–9 µm, with a gelatinous sheath. On thallus of an unidentified brown crustose lichen. See Hawksworth (1985). Distribution: 37 (unpubl.), 38 (Halıcı et al. 2007g) .... ***Phaeospora rimosicola** (Leight. ex Mudd) Hepp ex Stein 1879

94. Interascal filaments present **95**

95(94). Ascospores with 3-5(-7)-transsepta and 1(-2)-longisepta, the number of both kinds of septa increasing with age, often slightly constricted at the median septum, dark brown, cells similarly coloured, smooth, lacking a conspicuous gelatinous sheath, 21–26(–31.5) × (7–)9–12.5(–14.5) µm, irregularly biseriately arranged and overlapping in the ascus, broadly ellipsoid, rounded to somewhat broadly pointed at the apices, muriform. On apothecia of *Protoparmeliopsis muralis*. See Halıcı & Hawksworth (2008). Distribution: 27 (Halıcı & Hawksworth 2008) .... ***Dacampia muralicola*** Halici & D.Hawksw. 2008

95. Ascospores with 3 transsepta and 1(-2) longisepta, smooth-walled, slightly constricted at the septa, cells similarly coloured, lacking a conspicuous gelatinous sheath, (9.5–)10.5–12(–12.5) × (4.5–)5.5–6.5 μm, ellipsoid, pale brown, rounded to somewhat broadly pointed at the apices, muriform, irregularly biseriately arranged and overlapping in the asci. On squamules of *Cladonia* sp. See Halıcı et al. (2008). Distribution: 26, 45 (Halıcı et al. 2008) .... ***Dacampia cladoniicola*** Halici & A.O.Türk 2008

96(1). Conidia produced within pycnidia (coelomycetes) **97**

96. Conidia not produced within pycnidia (hyphomycetes) **107**

97(96). Conidia brown **98**

97. Conidia hyaline, narrowly obpyriform, simple, 12.5–17 × (4–)4.5–5(5.5–) μm, pycnidial wall pseudoparenchymatous. On *Xanthoparmelia stenophylla*. See Cole & Hawksworth (2001), Distribution: 14 (unpubl.) .... ***Vouaxiomyces*** anamorph of ***Abrothallus tulasnei*** M.S.Cole &D.Hawksw. 2001

98(97). Conidia arising in long chains **99**

98. Conidia arising singly **102**

99(98). Conidia simple, smooth-walled, (5–)6–8(–9) × 3–4 μm. On apothecia and rarely thallus of *Lecanora chlarotera* and *Lecanora* sp., See Sutton (1980) and Hawksworth (1981), Distribution: 28, 31 (Hafellner & John 2006), 61 (Etayo & Breuss 1998; Hafellner & John 2006), 26, 58 (unpubl.) .... ****Vouauxiella lichenicola*** (Linds.) Petr. & Syd. 1927

99. Conidia multicellular **100**

100(99). Conidia rough walled, 20–40 μm overall, deep olive to almost black. On *Bellemerea cinereorufescens* (mixed with *Muellerella pygmaea*). See Hawksworth (1981). Distribution: 38 (Hafellner & John 2006) .... ***Nigropuncta rugulosa*** D.Hawksw. 1981

100. Conidia smooth-walled or minutely verruculose **101**

101(100). Conidia subglobose, 12–15 μm, composed of 10-15 globose cells. Conidiomata 50–70 μm, On thallus of *Rhizoplaca peltata*. See Alstrup & Hawksworth (1990), Distribution: 51 (Halıcı et al. 2007c) .... ****Phaeosporobolus alpinus*** R. Sant., Alstrup & D. Hawksw. 1990

101. Conidia subglobose or ellipsoid, 15–35 μm, composed of 6-12 globose cells. Conidiomata (30–)50–75(–90) μm, On thallus of *Bryoria* sp., *B. capillaris*, *Ramalina calicaris*, *Usnea* sp., *U. barbata*, *U. filipendula*. See Hawksworth & Hafellner (1986). Distribution: 16, 26, 31 (Hafellner & John 2006) .... ***Phaeosporobolus usneae*** D.Hawksw. & Hafellner 1986

102(98). Conidia 1-septate **103**

102. Conidia simple **104**

103(102). Conidia pale brown to dark brown, smooth-walled with a truncate base; 4.5–5 × 2–2.5 µm. On apothecia of *Caloplaca holocarpa* and *Lecanora albella.* See Hawksworth & Dyko (1979) and Hawksworth (1981), Distribution: 38 (Halıcı et al. 2006), 67 (Hafellner & John 2006)
.... ***Lichenodiplis lecanorae** (Vouaux) Dyko & D.Hawksw. 1979

103. Conidia brown, smooth-walled with a truncate base, 10–12 × 4 µm. On apothecia of *Rinodina* sp. and *R. plana*, See Hawksworth & Dyko (1979) and Hawksworth (1981), Distribution: 42 (Halıcı et al. 2007g), 26 (unpubl.)
.... ***Lichenodiplis lichenicola** Dyko & D.Hawksw. 1979

104(103). Pycnidia mainly exceeding 100 µm diam, Conidia 2.5–4 × 3 µm, smooth-walled. On squamules of *Cladonia pyxidata* and *Cladonia* sp., See Hawksworth (1977a, 1981), Distribution: 14 (Halıcı & Cansaran-Duman 2007), 58 (unpubl.) .... ***Lichenoconium pyxidatae** (Oudem.) Petr. & Syd. 1927

104. Pycnidia mainly less than 80 µm diam **105**

105(104). Pycnidia 30–50 µm diam; conidia subglobose not truncated at the base, 2–3.5 µm. On thallus of *Parmeliopsis ambigua* and *Hypogymnia tubulosa*, See Hawksworth (1977a, 1981), Distribution: 35 (Hafellner & John 2006), 58 (unpubl.) .... ***Lichenoconium erodens** M.S.Christ. & D.Hawksw. 1977

105. Pycnidia mainly exceeding 50 µm diam; conidia mainly exceeding 3.5 µm diam **106**

106(105). Conidia verruculose, (2.5–)3–4(–5) µm diam; conidiogenous cells 7–10 µm. On apothecia of *Ramalina calicaris, Usnea* sp. and *U. barbata* and thallus of *Bryoria fuscescens*. See Hawksworth (1977a, 1981), Distribution: 16, 31, 61 (Hafellner & John 2006), 66(unpubl.)
.... ***Lichenoconium usneae** (Anzi) D.Hawksw. 1977

106. Conidia almost smooth, 3–5.5 µm diam; conidiogenous cells 5–7 µm. On apothecia and thallus of *Lecanora* sp., *L. chlarotera* and *Rhizoplaca chrysoleuca*, See Hawksworth (1977a, 1981), Distribution: 28, 61 (Hafellner & John 2006), 66 (Halıcı et al 2007c)
.... ***Lichenoconium lecanorae** (Jaap) D.Hawksw. 1979

107(96). Conidia hyaline at maturity, simple, refractive and truncated at the base, (15–)18–20(–25) × 6–7.5(–9) µm. On thallus of *Peltigera polydactylon.* See Hawksworth (1977b, 1979a). Distribution: 61: (John & Breuss 2004)
.... **Refractohilum peltigerae** (Keissl.) D.Hawksw. 1977

107. Conida brown at maturity, without refractive bases **108**

108(107). Conidia multicellular, arising as subglobose aggregations of cells, conidia 8–13 × 6–9.5 µm. On thallus of *Aspicilia* sp. See Hawksworth & Cole (2002). Distribution: 51 (Halıcı et al 2007c)
.... ***Intralichen baccisporus** D.Hawksw. & M.S.Cole 2002

108. Conidia 0-1-septate **109**

109(108). Conidia 1-septate, 5–8 × 4–7 µm. On apothecia and thallus of *Aspicilia caesiocinerea, A. contorta, Caloplaca variabilis, Lecanora carpinea, Parmelina quercina, Porpidia crustulata, Protoblastenia incrustans, Protoparmeliopsis muralis*. See Hawksworth & Cole (2002). Distribution: 02, 10, 17, 27 (Halıcı & Candan 2007), 14 (Halıcı & Cansaran-Duman 2007), 35 (Hafellner & John 2006), 51, 66 (Halıcı et al 2007c)
..... ****Intralichen christiansenii*** (D.Hawksw.) D.Hawksw. & M.S.Cole 2002

109. Conidia 0-septate, 3–5 × 2.5–4 µm. On thallus of *Anaptychia kaspica*. See Hawksworth & Cole (2002). Distribution: 38 (Halıcı et al 2007c)
.... ****Intralichen lichenum*** (Diederich) D.Hawksw. & M.S.Cole 2002

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Literature cited

Almquist S. 1880. Monographia Arthoniarum Scandinaviae. Kongl Svenska Vetensk. Akad. Handl. 17: 1-69.

Alstrup V. 1981. Notes on some lichens and lichenicolous fungi from Greenland. Nord. J. Bot. 1: 120-124.

Alstrup V, Hawksworth DL. 1990. The lichenicolous fungi of Greenland. Medd. Grønl. Bioscience 31: 1-90.

Atienza V, Calatayud V, Hawksworth DL. 2003. Notes on the genus *Polycoccum* (*Ascomycota, Decampiaceae*) in Spain, with a key to the species. Lichenologist 35: 125-135.

Calatayud Lorente V. 1998. Líquenes y hongos liquenícolas de rocas no carbonatadas en el Sistema Ibérico Oriental e Islas Columbretes. PhD thesis, Universitat de València.

Calatayud V, Triebel D. 1999. *Stigmidium neofusceliae* (*Dothideales* s.l.), a new lichenicolous fungus from Spain. Nova Hedwigia 69: 439-448.

Calatayud V, Navarro-Rosinés P, Hafellner J. 2002. A synopsis of *Lichenostigma* subgen. *Lichenogramma* (*Arthoniales*), with a key to the species. Mycological Research 106: 1230-1242.

Calatayud V, Barreno E, Rico VJ. 2004. Two lichenicolous species of *Arthonia* on vagrant *Aspicilia* species. In: Döbbeler P, Rambold G (eds.) Contributions to lichenology. Festschrift in honour of Hannes Hertel. Bibliotheca Lichenologica 88: 67-78.

Cole MS, Hawksworth DL. 2001. Lichenicolous fungi, mainly from the USA, including *Patriciomyces* gen. nov. Mycotaxon 77: 305-338.

Coppins BJ. 1992. *Arthonia* Ach. (1806). In: Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM (eds): The Lichen Flora of Great Britain and Ireland: 162-163. Natural History Museum Publications, London.

Çobanoğlu G, Akdemir B. 2004. Contribution to the lichen diversity of Nature Parks in Bolu and Çorum, Anatolia, Turkey. Herzogia 17: 129-136.

Diederich P. 1990. New or interesting lichenicolous fungi 1. Species from Luxembourg. Mycotaxon 37: 297-330.

Diederich P. 2003. New species and new records of American lichenicolous fungi. Herzogia 16: 41-90.

Diederich P, Christiansen MS. 1994. *Biatoropsis usnearum* Räsänen, and other *Heterobasidiomycetes* on *Usnea*. Lichenologist 26: 47-66.

Diederich P, Etayo J. 1994. Taxonomic notes on the genus *Plectocarpon* (lichenicolous fungi). Nordic Journal of Botany 14: 589-600.

Diederich P, Etayo J. 2000. A synopsis of the genera *Skyttea*, *Llimoniella* and *Rhymbocarpus* (Lichenicolous *Ascomycota*, *Leotiales*). Lichenologist 32: 423-485.

Diederich P, Sérusiaux E. 2000. The lichens and lichenicolous fungi of Belgium and Luxembourg. An annotated checklist. Musée national histoire naturalle, Luxembourg. 1-207.

Doré CJ, Cole MS, Hawksworth DL. 2006. Preliminary statistical studies of the infraspecific variation in the ascospores of *Nesolechia oxyspora* growing on different genera of parmelioid lichens. Lichenologist 38: 425-434.

Eriksson O. 1981. The families of bitunicate ascomycetes. Opera Botanica 60: 1-209.

Etayo J. 1994. Liquenes y hongos liquenicolas de los Pirineos occidentals, III. Candollea 49: 245-249.

Etayo J, Breuss O. 1998. New species and interesting records of lichenicolous fungi. Österr. Z. Pilsk. 7: 203-213.

Etayo J, Diederich P. 1998. Lichenicolous fungi from the Western Pyrenees, France and Spain. IV. *Ascomycetes*. Lichenologist 30: 103-120.

Faltynowicz W. 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. Biodiversity of Poland 6: 1-435.

Foucard T. 2001. Svenska Skorplavar och swampar som växer på dem. Interpublishing, Stockholm.

Galloway DJ, James PW. 1992. *Carbonea* (Hertel) Hertel (1983). In: Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM (eds): The Lichen Flora of Great Britain and Ireland: 162-163. Natural History Museum Publications, London.

Grube M, Hafellner J. 1990. Studien an flechtenbewohnenden Pilzen der Sammelgattung *Didymella* (*Ascomycetes, Dothideales*). Nova Hedwigia 51: 283-360.

Grube M, Matzer M. 1997. Taxonomic concepts of lichenicolous *Arthonia* species. Bibliotheca Lichenologica 68: 1-17.

Güvenç Ş, Öztürk Ş. 2004. Lichen records from the alpine region of Uludağ (Olympus) mountain in Bursa, Turkey. Turkish Journal of Botany 28: 299-306.

Hafellner J. 1979. *Karschia*. Revision einer Sammelgattung an der Grenze von lichenisierten und nichtlichenisierten Ascomyceten. Beih. Nova Hedwigia 62: 1-248.

Hafellner J. 1982. Studien über lichenicole Pilze und Flechten II. *Lichenostigma maureri* gen. et spec. nov. ein in der Ostalpen haufiger lichenicoler Pilz (*Ascomycetes, Arthoniales*). Herzogia 6: 299-308.

Hafellner J. 1985. Studien über lichenicole Pilze und Flechten III. Die Gattung *Roselliniella* Vainio emend. Haf. (*Ascomycotina, Dothideales*). Herzogia 7: 166-169.

Hafellner J. 1987a.Studien über lichenicole Pilze und Flechten V. Über die Gattung *Phacopsis* Tul. emend. Körber (*Lecanorales*). Herzogia 7: 343-352.

Hafellner J. 1987b.Studien über lichenicole Pilze und Flechten VI. Ein verandertes Gattungskonzept für *Cercidospora*. Herzogia 7: 353-365.

Hafellner J. 1994. Beiträge zu einem Prodromus der licheicolen Pilze Österreichs und angrenzender Gebiete I. Einige neue oder seltene Arten. Herzogia 10: 1-28.

Hafellner J. 2004. Notes on *Scoliciosporum intrusum*. Fritschiana 49: 29-41.

Hafellner J, Navarro-Rosinés P. 1993. *Llimoniella* gen.nov.- eine weitere Gattung lichenicoler Discomyceten (*Ascomycotina, Leotiales*. Herzogia 9: 769-778.

Hafellner J, Calatayud V. 1999. *Lichenostigma cosmopolites*, a common lichenicolous fungus on *Xanthoparmelia* species. Mycotaxon 72: 107-114.

Hafellner J, John V. 2006. Über funde lichenicoler nicht-lichenisierter Pilze in der Türkei, mit einer Synopsis der bisher im Land nachgewiesenen Taxa. Herzogia 19: 155-176.

Halıcı MG, Candan M. 2007. Notes on some lichenicolous fungi from Turkey. Turkish Journal of Botany 31: 353-356.

Halıcı MG, Hawksworth DL. 2007. Two new species of lichenicolous fungi from Turkey. Lichenologist 39: 439-443.

Halıcı MG, Cansaran Duman D. 2007. Lichenized and lichenicolous fungi of Yaylacık (Bolu) and Yenice (Karabük) Research forests. Mycologica Balcanica 4: 97-103.

Halıcı MG, Hawksworth DL. 2008. Two new species of *Dacampia* (*Ascomycota*, *Dacampiaceae*), with a key to and synopsis of the known species of the genus. Fungal Diversity 28: 49-54.

Halıcı MG, Orange A, Aksoy A. 2005a. *Weddellomyces turcicus*, a new species on a grey *Acarospora* from Turkey. Mycotaxon 94: 249-252.

Halıcı MG, John V, Aksoy A. 2005b. Lichens of Erciyes Mountain (Kayseri, Turkey). Fl. Medit. 15: 567-580.

Halıcı MG, Kocakaya M, Aksoy A. 2006. Additional and interesting lichenized and lichenicolous fungi from Turkey. Mycotaxon 96: 13-19.

Halıcı MG, Kocourková J, Diederich P, Aksoy A. 2007a. *Endococcus variabilis*, a new species on *Staurothele areolata*. Mycotaxon 100: 337-342.

Halıcı MG, Atienza V, Hawksworth DL. 2007b. Two new *Polycoccum* species from Turkey. Mycotaxon 101: 157-163.

Halıcı MG, Hawksworth DL, Aksoy A. 2007c. New and interesting lichenicolous fungi records from Turkey. Nova Hedwigia 85: 393-401.

Halıcı MG, Özdemir Türk A, Candan M. 2007d. New records of pyrenocarpous lichenicolous fungi from Turkey. Mycotaxon 99: 201-206.

Halıcı MG, Candan M, Özdemir Türk A. 2007e. New records of lichenicolous and lichenized fungi from Turkey. Mycotaxon 100: 255-260.

Halıcı MG, Aksoy A, Kocakaya M. 2007f. Some lichens from Gaziantep, Kahramanmaraş, Kırşehir and Yozgat Provinces (Turkey). Turkish Journal of Botany 31: 161-170.

Halıcı MG, Hawksworth DL, Aksoy A. 2007g. Contributions to the lichenized and lichenicolous fungal biota of Turkey. Mycotaxon 102: 403-414.

Halıcı MG, Özdemir Türk A, Candan M. 2008. *Dacampia cladoniicola* sp. nov. (*Ascomycota*, *Dacampiaceae*), on *Cladonia* sp. from Turkey. Mycotaxon 103: 53-57.

Halıcı MG, Hawksworth, DL, Candan M, Özdemir Türk A. 2008. A new lichenicolous species of *Capronia* (*Ascomycota*, *Herpotrichiellaceae*), from Turkey with a key to the known lichenicolous species of the genus. Fungal Diversity 29: in press.

Hawksworth DL. 1975. Notes on British lichenicolous fungi, I. Kew Bull. 30: 183-203.

Hawksworth DL. 1977a. Taxonomic and biological observations on the genus *Lichenoconium* (*Sphaeropsidales*). Persoonia 9: 159-198.

Hawksworth DL. 1977b. Three new genera of lichenicolous fungi. Bot. J. Linn. Soc. 75: 195-209.

Hawksworth DL. 1979a. The lichenicolous hyphomycetes. Bull. Brit. Mus. (Nat. Hist.), Bot. 6: 183-300.

Hawksworth DL. 1979b. Studies in the genus *Endococcus* (*Ascomycotina, Dothideales*). Bot. Notiser 132: 283-290.

Hawksworth DL. 1980. Notes on British lichenicolous fungi: III. Notes Roy. Bot. Gard. Edinburgh 38: 165-183.

Hawksworth DL. 1981. The lichenicolous coelomycetes. Bull. Br. Mus. nat. Hist., Bot. 9: 1-98.

Hawksworth DL. 1982. *Melaspilea canariensis* sp. nov. and other lichenicolous fungi from Tenerife. Lichenologist 14: 83-86.

Hawksworth DL. 1983. A key to the lichen-forming, parasitic, parasymbiotic and saprophytic fungi occurring on lichens in the British Isles. Lichenologist 15: 1-44.

Hawksworth DL. 1985. A redisposition of the specie referred to the ascomycete genus *Microthelia*. Bull. Brit. Mus. (Nat. Hist.), Bot. 14: 43-181.

Hawksworth DL. 1988. The variety of fungal-algal symbioses, their evolutionary significance, and the nature of lichens. Botanical journal of the Linnean Society of London 96: 3-20.

Hawksworth DL. 1990. Notes on British lichenicolous fungi: VI. Notes Roy. Bot. Gdn Edinb. 46: 391-403.

Hawksworth DL. 2001. The magnitude of fungal diversity: the 1.5 million species estimate revisited. Mycological Research 05: 1422-1432.

Hawksworth DL. 2003.The lichenicolous fungi of Great Britain and Ireland: an overview and annotated checklist. Lichenologist 35: 191-232.

Hawksworth DL, Dyko BJ. 1979. *Lichenodiplis* and *Vouaxiomyces*: two new genera of lichenicolous coelomycetes. Lichenologist 11: 51-61.

Hawksworth DL, Hafellner J. 1986. *Phaeosporobolus usneae*, a new and widespread lichenicolous deuteromycete. Nova Hedwigia 43: 525-530.

Hawksworth DL, Diederich P. 1988. A synopsis of the genus *Polycoccum* (*Dothideales*), with a key to accepted species. Trans. Br. Mycol. Soc. 90: 293-312.

Hawksworth DL, Cole MS. 2002. *Intralichen*, a new genus for lichenicolous '*Bispora*' and*Trimmatostroma* species. Fungal Diversity 11: 87-97.

Hawksworth DL, Halıcı MG. 2007. *Gemmaspora*, a new verrucarialean genus with remarkable ascospores for *Adelococcus lecanorae* growing on *Aspicilia* species in Syria and Turkey. Lichenologist 39: 121-128.

Hertel H. 1969. Beiträge zur Kenntnis der Flechtenfamilie *Lecideaceae* II. Herzogia 1: 321-329.

Hertel H. 1983. Über einige aus *Lecidea* and *Melanolechia* (*Ascomycetes* lichenisati) auszuscliessende Arten. Mitt. Bot. München 19: 441-447.

Hezarfen B, Özdemir Türk A, Candan M. 2001. Yeşildağ (Kütahya-Bilecik) liken florası. Anadolu Univ. J. Sci. Techn. 2: 203-209.

Hoffmann N, Hafellner J. 2000. Eine Revision der lichenicolen Arten der Sammelgattungen *Guignardia* und *Physalospora*. Bibliotheca Lichenologica 77: 1-181.

Ihlen PG, Wedin M. 2008. An annotated key to the lichenicolous *Ascomycota* and mitosporic fungi of Sweden. Nova Hedwigia: in press.

IPNI. 2008. The International Plant Names Index, Author Query. http://www.ipni.org/ipni/authorsearchpage.do.

John V. 1996. Preliminary catalogue of lichenized and lichenicolous fungi of Mediterranean Turkey. Bocconea 6: 173-216.

John V. 1999. Lichenes anatolici exsiccati. Fasc. 1-3 (no. 1-75). Arnoldia 16: 1-44.

John V. 2000. Lichenes anatolici exsiccati. Fasc. 4-5 (no. 76-125). Arnoldia 19: 1-27.

John V, Breuss O. 2004. Flechten der östlichen Schwarzmeer-Region in der Türkei (BLAM-Exkursion 1997). Herzogia 17: 137-156.

Keissler K. 1930. Die Flechtenparasiten. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz 8: i- xi, 1-712.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the fungi, 9th Edition. CABI Publishing, Wallingford, Oxon.

Kocourková J. 2000. Lichenicolous fungi of the Czech Republic (the first commented checklist). Acta Musei Nationalis Pragae, B55: 59-169.

Kotte I. 1909. Einige neue Fälle von Nebensymbiose (Parasymbiose.). Zbl. Bakteriol. 24: 74-93.

Lawrey JD, Diederich P. 2003. Lichenicolous fungi: interactions, evolution and biodiversity. Bryologist 106: 80-120.

Lowen R. 1989. Two new species of *Nectriella* and an *Acremonium* anamorph. Memoirs of the New York Botanical Garden 49: 243-252.

Löfgren O, Tibell L. 1979. *Sphinctrina* in Europe. Lichenologist 11: 109-137.

Matzer M, Hafellner J. 1990. Eine Revision der lichenicolen Arten de samelgattung *Rosellinia* (*Ascomycetes*). Biblioheca Lichenologica 37: 1-138.

Matzer M, Pelzmann B. 1991. REM-Studien an Ascosporen der lichenicolen Gattungen *Adelococcus, Reconditella, Roselliniella* und *Roselliniopsis*. Nova Hedwigia 52: 1-9.

Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F. 2004. Lichen Flora of the Greater Sonoran Desert Region.Vol. 2. Tempe: Arizona State University.

Navarro-Rosinés P, Roux C. 1995. La genre *Weddellomyces* (*Dothideales, Decampiaceae*) en Catalogne et en Provence. Mycotaxon 53: 161-189.

Navarro-Rosinés P, Hafellner J. 1996. *Lichenostigma elongata* spec. nov. (*Dothideales*), a lichenicolous ascomycete on *Lobothallia* and *Aspicilia* species. Mycotaxon 57: 211-225.

Özdemir Türk A. 2002. Eskişehir ili liken florasına katkılar. Ot Sistematik Botanik Dergisi 9: 149-165.

Rambold G, Hertel H, Triebel D. 1990. *Koerberiella wimmeriana* (*Lecanorales*, *Porpidiaceae*) and its lichenicolous fungi. Lichenologist 22: 225-240.

Richardson DHS. 1999. War in the world of lichens: parasites and symbiosis as exemplified by lichens and lichenicolous fungi. Mycological Research 103: 641-650.

Roux C, Triebel D. 1994. Révision des espéces de *Stigmidium* et de *Sphaerellothecium* (champignons lichénicoles on lichénisés, ascomycetes) corresponsant á *Pharcidia epicymatia* sensu Keissler ou á *Stigmidium schaereri* auct. Bull. Soc. Linn. Provence 45: 451-542.

Roux C, Triebel D, Bricaud O, Le Coeur D. 1995. Le *Stigmidum lecidellae* sp. nov. et remarques sur la genre *Stigmidium* (champignons lichénicoles no lichénisés, Ascomycetes). Canad J. Bot. 73:662-672.

Santesson R. 1960. Lichenicolous fungi from northern Spain. Svensk bot. Tidskr. 54: 499-522.

Santesson R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. Lund, 1-240.

Scholz P. 2000. Katalog der Flechten und flechtenbewohnenden Pilze Deutschlands. Schriftenreihe der Vegetationskunde 31: 1-298.

Sérusiaux E, Diederich P, Brand AM, Van Den Boom P. 1999. New or interesting lichens and lichenicolous fungi from Belgium and Luxembourg. VIII. Lejeunia 162: 1-95.

Steiner J. 1899. Lichenes. In: Fritsch K. Beitrag zur Flora von Constantinopel. Bearbeitung der von J. Nemetz in den Jahren 1894-1897 in den Umgebungen von Constantinopel gesammelten Pflanzen. I. Kryptogamen. Denkschr. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Cl. 68: 222-238.

Steiner J. 1905. Lichenes. In: Ergebnisse einer naturwissenschaftlichen Reise zum Erdschias-Dagh (Kleinasien). Ausgeführt von Dr. Arnold Penther und Dr. Emerich Zederbauer auf Kosten der ‚Gesellschaft zur Förderung der naturhistorischen Erforschung des Orients in Wien' (nunmehr ‚Naturwissenschaftlicher Orientverein in Wien') im Jahre 1902. Ann. K.-K. Naturhist. Hofmus. Wien 20: 369-384.

Sutton BC. 1980. The Coelomycetes. Commonwealth Mycological Institute, Kew, Surrey.

Thor G. 1985. A new species of *Lichenostigma*, a lichenicolous ascomycete. Lichenologist 17: 269-272.

Tibell L. 1999. Calicioid lichens and fungi. Nordic Lichen Flora 1: 20-94.

Timdal E. 1991. A monograph of the genus *Toninia* (*Lecideaceae, Ascomycetes*). Opera Botanica 110: 1-137.

Triebel D. 1989. Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. Bibliotheca Lichenologica 35: 1-278.

Triebel D. 1993. Notes on the genus *Sagediopsis* (*Verrucariales*, *Adelococcaceae*). Sendtnera 1: 273-280.

Triebel D, Rambold G. 1988. *Cecidonia* and *Phacopsis* (*Lecanorales*): zwei lichenicole Pilzgattungen mit cecidogenen Arten. Nova Hedwigia 47: 279-309.

Triebel D, Cáceres MES. 2004. *Stigmidium*, pp. 703-707. In Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F. 2004. Lichen Flora of the Greater Sonoran Desert Region.Vol. 2. Tempe: Arizona State University.

Triebel D, Rambold G, Elix JA. 1995. A conspectus of the genus *Phacopsis* (*Lecanorales*). The Bryologist 98: 71-83.

Vězda A. 1970. Beitrage zur Kenntnis der Flechtenbewohnende Pilze in der Tschechoslowakei III. Ceskà Mykol. 24: 220-229.

Vouaux MLA. 1912. Synopsis des Champignons parasites de Lichens. Bull. Trimest. Soc. Mycol. Fr. 29: 33-128.

Weddell HA. 1874. Florule lichénique des laves d'Agde (1). Bull. Soc. Bot. France 21: 330-347.

Winter G. 1884-87. Ascomyceten: Gymnoasceen und Pyrenomyceten. Rabenh. Krypt. Fl. 1(2): 1-928.

Wirth V. 1995. Die Flechten Baden-Württembergs. Teil 1-2. Stuttgart, Ulmer.

Yazıcı K, Aslan A. 2006. Lichen taxonomic composition from MustafaKemalpaşa, Bursa district (Turkey). Acta Bot. Croat. 65: 25-39.

Yazıcı K, Aslan A. 2007. Lichens and lichenicolous fungi from Bayburt province. Acta Botanica Hungarica 49: 199-213.

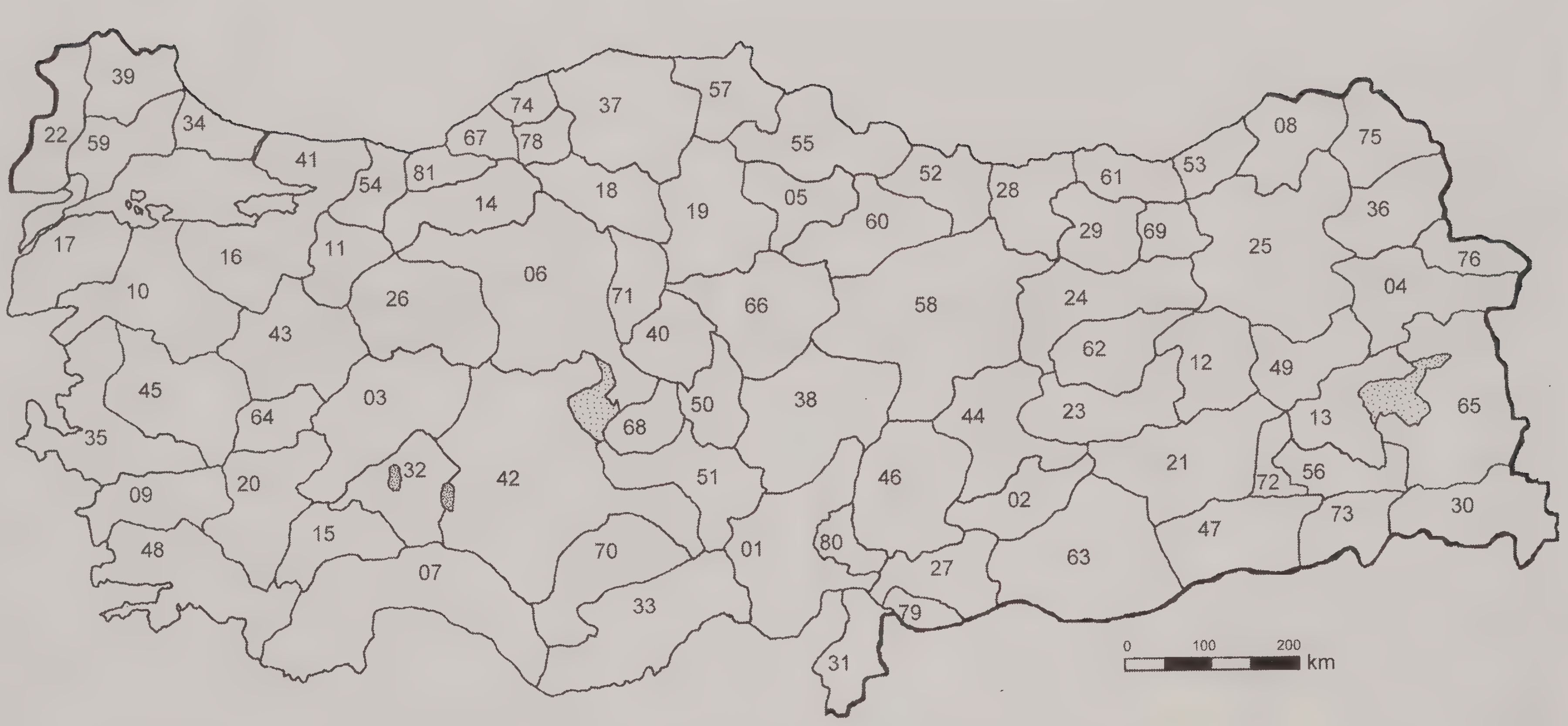
Zhurbenko M, Alstrup V. 2004. Lichenicolous fungi on Cladonia mainly from the Arctic. Symb. Bot. Upsal. 34: 477-499.

Zopf W. 1897. Untersuchungen über die durch parasitische Pile hervorgerufenen Krankheiten der Flechten. Nova Acta Abhandl. Kaiserl. Leop. Carol Deutschen Akad. Naturf. 70: 99-188.

Zopf W. 1898. Untersuchungen über die durch parasitische Pile hervorgerufenen Krankheiten der Flechten. Nova Acta Abhandl. Kaiserl. Leop. Carol Deutschen Akad. Naturf. 70: 243-288.

Table 1. Vehicle registration codes for each province.

Codes	Provinces
01	Adana
02	Adıyaman
03	Afyon
04	Ağrı
05	Amasya
06	Ankara
07	Antalya
08	Artvin
09	Aydın
10	Balıkesir
11	Bilecik
12	Bingöl
13	Bitlis
14	Bolu
15	Burdur
16	Bursa
17	Çanakkale
18	Çankırı
19	Çorum
20	Denizli
21	Diyarbakır
22	Edirne
23	Elazığ
24	Erzincan
25	Erzurum
26	Eskişehir
27	Gaziantep
28	Giresun
29	Gümüşhane
30	Hakkari
31	Hatay
32	Isparta
33	İçel
34	İstanbul
35	İzmir
36	Kars
37	Kastamonu
38	Kayseri
39	Kırklareli
40	Kırşehir
41	Kocaeli
42	Konya
43	Kütahya
44	Malatya
45	Manisa
46	Kahramanmaraş
47	Mardin
48	Muğla
49	Muş
50	Nevşehir
51	Niğde
52	Ordu
53	Rize
54	Sakarya
55	Samsun
56	Siirt
57	Sinop
58	Sivas
59	Tekirdağ
60	Tokat
61	Trabzon
62	Tunceli
63	Şanlıurfa
64	Uşak
65	Van
66	Yozgat
67	Zonguldak
68	Aksaray
69	Bayburt
70	Karaman
71	Kırıkkale
72	Batman
73	Şırnak
74	Bartın
75	Ardahan
76	Iğdır
77	Yalova
78	Karabük
79	Kilis
80	Osmaniye
81	Düzce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02
21
56
72
30
09
20
15
07
70
01
80
27
63
47
73
48
33
79
31
0
100
200
km

Fig. 1. Turkish provinces and their vehicle registration codes.

Table 2. Index of species treated

SPECIES	KEY COUPLET
Abrothallus *bertianus*	33
Abrothallus parmeliarum	35
Abrothallus prodiens	36
Abrothallus tulasnei	36, 97
Abrothallus usneae	34
Adelococcus *immersus*	78
Arthonia *clemens*	13
Arthonia epiphyscia	16
Arthonia excentrica	14
Arthonia hertelii	12
Arthonia intexta	10
Arthonia molendoi	15
Arthonia phaeophysciae	16
Arthonia subfuscicola	11
Arthonia varians	11
Capronia *minutosetosae*	88
Carbonea *aggregantula*	28
Carbonea supersparsa	27
Carbonea vitellinaria	29
Cercidospora *caudata*	51
Cercidospora epicarphinea	54
Cercidospora epipolytropa	54
Cercidospora macrospora	53
Cercidospora solearispora	50
Cercidospora xanthoriae	52
Chaenothecopsis *consociata*	4
Clypeococcum *hypcenomycis*	69
Dacampia *cladoniicola*	95
Dacampia muralicola	95
Dactylospora *homoclinella*	38
Dactylospora lobariella	37
Dactylospora saxatilis	38
Echinothecium *reticulatum*	44
Endococcus *exerrans*	84
Endococcus macrosporus	86
Endococcus nanellus	84
Endococcus propinquus	85
Endococcus pseudocarpus	87
Endococcus rugulosus	87

Table 2. Index of species, continued

SPECIES	KEY COUPLET
Endococcus stigma	81
Endococcus variabilis	80
Endococcus verrucosus	82
***Gemmaspora** lecanorae*	79
***Intralichen** baccisporus*	108
Intralichen christiansenii	109
Intralichen lichenum	109
***Lichenoconium** erodens*	105
Lichenoconium lecanorae	106
Lichenoconium pyxidatae	104
Lichenoconium usneae	106
***Lichenodiplis** lecanorae*	103
Lichenodiplis lichenicola	103
***Lichenostigma** cosmopolites*	62
Lichenostigma elongatum	62
Lichenostigma maureri	63
Lichenostigma rugosum	63
Lichenostigma triseptatum	60
***Llimoniella** scabridula*	31
***Melaspilea** canariensis*	6
***Muellerella** erratica*	67
Muellerella lichenicola	65
Muellerella pygmaea	66
Muellerella ventosicola	67
Muellerella vesicularia	92
***Nesolechia** oxyspora*	24
***Nigropuncta** rugulosa*	100
***Opegrapha** glaucomaria*	7
Opegrapha pulvinata	7
***Phacopsis** cephalodioides*	25
Phacopsis vulpina	25
***Phaeospora** rimosicola*	94
***Phaeosporobolus** alpinus*	101
Phaeosporobolus usneae	101
***Plectocarpon** lichenum*	20
Plectocarpon scrobiculatae	20
***Polycoccum** acarosporicola*	75
Polycoccum aksoyi	71
Polycoccum crassum	73

Table 2. Index of species, concluded

SPECIES	KEY COUPLET
Polycoccum dzieduszyckii	72
Polycoccum marmoratum	74
Polycoccum microstictum	71
Polycoccum sporastatiae	75
***Pronectria** leptaleae*	43
***Pyrenidium** actinellum*	93
***Refractohilum** peltigerae*	107
***Rhymbocarpus** geographici*	30
***Roselliniella** cladoniae*	56
***Rosellinula** frustulosae*	57
Rosellinula haplospora	57
***Sagediopsis** desertorum*	42
***Scoliciosporum** intrusum*	29
***Sphaerellothecium** cladoniae*	77
Sphaerellothecium parmeliae	77
***Sphinctrina** turbinata*	4
***Stigmidium** cerinae*	46g
Stigmidium congestum	46i
Stigmidium eucline	46h
Stigmidium gyrophorarum	46a
Stigmidium johnii	46f
Stigmidium psorae	46d
Stigmidium pumilum	46b
Stigmidium squamariae	46j
Stigmidium tabacinae	46e
Stigmidium xanthoparmeliarum	46c
***Telogalla** olivieri*	41
***Toninia** episema*	22
Toninia plumbina	21
Toninia subfuscae	22
***Unguiculariopsis** groenlandiae*	31
***Vouauxiella** lichenicola*	99
***Weddellomyces** heterochrous*	91
Weddellomyces macrosporus	91
Weddellomyces turcicus	90
***Zwackhiomyces** coepulonus*	49
Zwackhiomyces lecanorae	41
Zwackhiomyces lithoiceae	48
Zwackhiomyces sphinctrinoides	49

Table 3. Host index.

HOST LICHEN	LICHENICOLOUS FUNGI
Acarospora sp.	*Muellerella pygmaea*
	Polycoccum microstictum
	Weddellomyces turcicus
Acarospora cervina	*Polycoccum acarosporicola*
	Weddellomyces turcicus
Acarospora fuscata	*Muellerella pygmaea*
Acarospora nodulosa var. *reagens*	*Llimoniella scabridula*
Anaptychia kaspica	*Intralichen lichenum*
Aspicilia sp.	*Endococcus rugulosus*
	Endococcus verrucosus
	Intralichen baccisporus
	Lichenostigma triseptatum
	Lichenostigma elongatum
	Muellerella lichenicola
	Muellerella pygmaea
	Weddellomyces heterochrous
	Weddellomyces macrosporus
Aspicilia caesiocinerea	*Intralichen christianenii*
	Lichenostigma triseptatum
	Muellerella pygmaea
Aspicilia calcarea	*Gemmaspora lecanorae*
	Muellerella erratica
	Muellerella lichenicola
	Muellerella pygmaea
Aspicilia cinerea	*Polycoccum aksoyi*
Aspicilia contorta	*Intralichen christianenii*
	Muellerella pygmaea
	Zwackhiomyces lecanorae
Aspicilia contorta subsp. *hoffmanniana*	*Carbonea supersparsa*
	Dactylospora homoclinella
	Toninia episema
Aspicilia coronata	*Toninia episema*
Aspicilia intermutans	*Rosellinula haplospora*
Bellemerea cinereorufescens	*Nigropuncta rugulosa*
Bryoria sp.	*Phaeosporobolus usneae*
Bryoria capillaris	*Phaeosporobolus usneae*
Bryoria fuscescens	*Lichenoconium usneae*
Caloplaca sp.	*Arthonia molendoi*
	Cercidospora epicarphinea

Table 3. Host index, continued

HOST LICHEN	**LICHENICOLOUS FUNGI**
Caloplaca sp. (continued)	*Muellerella erratica*
	Muellerella pygmaea
	Stigmidium johnii
	Zwackhiomyces coepulonus
	Zwackhiomyces sphinctrinoides
Caloplaca aurantia	*Cercidospora caudata*
Caloplaca biatorina	*Arthonia molendoi*
	Cercidospora xanthoriae
Caloplaca chalybaea	*Cercidospora caudata*
Caloplaca cerina var. *muscorum*	*Stigmidium cerinae*
Caloplaca decipiens	*Arthonia molendoi*
Caloplaca erodens	*Zwackhiomyces coepulonus*
Caloplaca flavescens	*Cercidospora caudata*
Caloplaca flavovirescens	*Muellerella pygmaea*
	Zwackhiomyces coepulonus
Caloplaca holocarpa	*Lichenodiplis lecanorae*
Caloplaca lactea	*Unguiculariopsis groenlandiae*
	Zwackhiomyces coepulonus
Caloplaca lobulata	*Arthonia molendoi*
Caloplaca saxicola	*Arthonia molendoi*
Caloplaca trachyphylla	*Arthonia molendoi*
	Muellerella pygmaea
Caloplaca variabilis	*Intralichen christiansenii*
	Zwackhiomyces sphinctrinoides
Candelariella coralliza	*Carbonea vitellinaria*
Candelariella vitellina	*Carbonea vitellinaria*
Chaenotheca chrysocephala	*Chaenothecopsis consociata*
Chromatochlamys muscorum	*Capronia minutosetosae*
Cladonia sp.	*Dacampia cladoniicola*
	Lichenoconium pyxidatae
Cladonia pyxidata	*Lichenoconium pyxidatae*
	Roselliniella cladoniae
	Sphaerellothecium cladoniae
Clauzadea monticola	*Muellerella erratica*
Collema sp.	*Endococcus pseudocarpus*
Degelia plumbea	*Toninia plumbina*
Dermatocarpon biennense	*Adelococcus immersus*
Dermatocarpon pellitum	*Opegrapha pulvinata*
Hypocenomyce scalaris	*Clypeococcum hypocenomycis*

Table 3. Host index, continued

HOST LICHEN	LICHENICOLOUS FUNGI
Hypogymnia laminisorediata	*Phacopsis cephalodioides*
Hypogymnia physodes	*Abrothallus prodiens*
Hypogymnia tubulosa	*Echinothecium reticulatum*
	Lichenoconium erodens
	Lichenostigma maureri
Lecanora sp.	*Lichenoconium lecanorae*
	Muellerella pygmaea
	Vouauxiella lichenicola
Lecanora albella	*Lichenodiplis lecanorae*
Lecanora bicincta	*Arthonia varians*
Lecanora carpinea	*Arthonia subfuscicola*
	Intralichen christiansenii
Lecanora chlarotera	*Lichenoconium lecanorae*
	Stigmidium congestum
	Vouauxiella lichenicola
Lecanora dispersoareolata	*Carbonea aggregantula*
	Muellerella pygmaea
Lecanora frustulosa	*Rosellinula frustulosae*
Lecanora garovaglii	*Muellerella pygmaea*
Lecanora polytropa	*Cercidospora epipolytropa*
	Muellerella erratica
	Muellerella pygmaea
Lecanora rupicola	*Arthonia varians*
Lecanora sulphurata	*Arthonia varians*
	Opegrapha glaucomaria
Lecidea sp.	*Muellerella pygmaea*
Lecidea confluens	*Muellerella lichenicola*
Lecidea fuscoatra	*Endococcus rugulosus*
	Muellerella vesicularia
Lecidella carpathica	*Endococcus exerrans*
	Endococcus stigma
Lecidella stigmatea	*Muellerella erratica*
Lepraria caesioalba	*Arthonia excentrica*
Letharia vulpina	*Phacopsis vulpina*
Lobaria pulmonaria	*Dactylospora lobariella*
	Plectocarpon lichenum
Lobaria scrobiculata	*Plectocarpon scrobiculatae*
Lobothallia radiosa	*Lichenostigma elongatum*
	Muellerella pygmaea
	Zwackhiomyces lecanorae
	Zwackhiomyces lithoiceae

Table 3. Host index, continued

HOST LICHEN	LICHENICOLOUS FUNGI
Melanelixia fuliginosa	*Abrothallus bertianus*
Parmelia saxatilis	*Abrothallus parmeliarum*
	Nesolechia oxyspora
	Sphaerellothecium parmeliae
Parmelia submontana	*Nesolechia oxyspora*
Parmelina quercina	*Intralichen christiansenii*
Parmelina tiliacea	*Nesolechia oxyspora*
Parmeliopsis ambigua	*Lichenoconium erodens*
Peltigera sp.	*Polycoccum crassum*
Peltigera polydactylon	*Refractohilum peltigerae*
Pertusaria sp.	*Dactylospora saxatilis*
	Melaspilea canariensis
	Sphinctrina turbinata
Pertusaria lactea	*Stigmidium eucline*
Phaeophyscia orbicularis	*Arthonia phaeophysciae*
Physcia sp.	*Stigmidium pumilum*
Physcia semipinnata	*Arthonia epiphyscia*
	Pronectria leptaleae
Porpidia crustulata	*Intralichen christiansenii*
Protoblastenia incrustans	*Intralichen christiansenii*
Protoparmeliopsis muralis	*Arthonia intexta*
	Cercidospora macrospora
	Dacampia muralicola
	Intralichen christiansenii
	Stigmidium squamariae
	Toninia subfuscae
Pseudevernia furfuracea	*Lichenostigma maureri*
Psora decipiens	*Stigmidium psorae*
Ramalina calicaris	*Lichenoconium usneae*
	Phaeosporobolus usneae
Rhizocarpon sp.	*Rhymbocarpus geographici*
Rhizocarpon geographicum	*Endococcus macrosporus*
	Muellerella pygmaea
	Muellerella ventosicola
	Scoliciosporum intrusum
Rhizoplaca chrysoleuca	*Arthonia clemens*
	Lichenoconium lecanorae
Rhizoplaca melanophtalma	*Cercidospora macrospora*
Rhizoplaca peltata	*Muellerella pygmaea*
	Phaeosporobolus alpinus
Rinodina sp.	*Lichenodiplis lichenicola*

Table 3. Host index, concluded

HOST LICHEN	LICHENICOLOUS FUNGI
Rinodina plana	*Lichenodiplis lichenicola*
Sphaerothallia desertorum	*Arthonia hertelii*
	Sagediopsis desertorum
Sporastatia testudinea	*Polycoccum sporastatiae*
Staurothele areolata	*Endococcus variabilis*
Stereocaulon vesuvianum	*Endococcus nanellus*
Toninia sp.	*Stigmidium tabacinae*
Toninia sedifolia	*Stigmidium tabacinae*
Umbilicaria sp.	*Stigmidium gyrophorarum*
Umbilicaria leiocarpa	*Stigmidium gyrophorarum*
Usnea sp.	*Abrothallus usneae*
	Phaeosporobolus usneae
	Lichenoconium usneae
Usnea barbata	*Lichenoconium usneae*
	Phaeosporobolus usneae
Usnea filipendula	*Phaeosporobolus usneae*
Usnea subfloridana	*Lichenostigma maureri*
Verrucaria sp.	*Polycoccum marmoratum*
Verrucaria calciseda	*Polycoccum dzieduszyckii*
Xanthoparmelia sp.	*Stigmidium xanthoparmeliarum*
Xanthoparmelia conspersa	*Nesolechia oxyspora*
Xanthoparmelia stenophylla	*Abrothallus tulasnei*
	Lichenostigma cosmopolites
Xanthoparmelia tinctina	*Nesolechia oxyspora*
	Lichenostigma cosmopolites
Xanthoparmelia verruculifera	*Nesolechia oxyspora*
Xanthoria elegans	*Arthonia molendoi*
	Cercidospora xanthoriae
	Muellerella pygmaea
	Zwackhiomyces coepulonus
	Zwackhiomyces sphinctrinoides
Xanthoria parietina	*Telogalla olivieri*
Unidentified	*Cercidospora solearispora*
	Endococcus propinquus
	Phaeospora rimosicola
	Pyrenidium actinellum
	Toninia subfuscae

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Pyrenomycetes of the Russian Far East 3. Three new *Daldinia* species (*Xylariaceae*)

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Abstract — Three new species - *Daldinia barkalovii, D. govorovae,* and *D. carpinicola* - are described and illustrated. Eastern Russia is characterized by a rather unusual species composition and might be considered as one of the centers of rapid species radiation.

Key words — *Ascomycota, Sordariomycetes,* systematics, biogeography

Introduction

The genus *Daldinia* Ces. & De Not. (*Xylariaceae*) has received much attention in recent years (Ju et al. 1997, 1999, Rogers et al. 1999, Wollweber & Stadler 2001, Stadler et al. 2004). The keys for 21 accepted species were provided (Ju et al. 1997, Rogers et al. 1999). The members of *Daldinia* are associated with angiosperm plants and widely distributed over the world but their true biogeographic areas and relationships are still to be discovered.

The first record of "*D. concentrica* (Bolton : Fr.) Ces. & De Not." in the Russian Far East was reported from Kamchatka Peninsula by Tranzschel (1914). Several mycologists specializing in different groups of fungi have previously collected "*D. concentrica*" in this area (Lyubarsky 1952, 1961, Koval & Nelen 1959, Tomilin 1962, 1966, Ablakatova et al. 1964, Vasilkov 1969, Koval 1972, Bunkina & Nazarova 1978). Dennis (1971) identified specimens collected by A. Raitviir and E. Parmasto in 1961, reporting also "*D. bakeri*" Lloyd, "*D. occidentalis*" Child, and "*D. vernicosa*" (Schwein.) Ces. & De Not. in addition to "*D. concentrica*".

Daldinia bakeri recently has been found to be a Southern Hemisphere species (Ju et al. 1997, Stadler et al. 2004), and *D. concentrica* appears to occur mainly on *Fraxinus* in Europe, while many specimens identified as "*D. concentrica*" from eastern Russia belong to *D. childiae* J.D. Rogers & Y.M. Ju (Rogers et al. 1999) (cf. Fig 1). The specimens of "*D. occidentalis*" correspond to *D. loculata* (Lév.) Sacc., which was reported by Johannesson et al. (2000) from Eastern Russia, and their results were confirmed by Stadler et al. (2001a,b,c), based on chemotaxonomic methodology and morphological studies, including SEM data of ascospores and the characterization of its anamorphic structures.

The illegitimate name *D. vernicosa* was regarded by Ju et al. (1997) as a synonym of *D. fissa* Lloyd, but the latter may actually circumscribe a species complex. The specimens from northeastern Asia have comparatively small (about 1 cm wide) and brownish stromata (Fig 2). It has been already noted that records of the same *Daldinia* species from different geographic localities and hosts do not necessarily constitute widely distributed or even cosmopolitan taxa (Stadler et al. 2004). Additionally, a certain geographic area could be inhabited by very unusual species complexes; northeastern Asia is a most interesting area in this respect, as it appears to be one of the centers of rapid species radiation in certain groups of fungi (cf. Petersen & Hughes 2007).

The monograph on the pyrenomycetous fungi of the Russian Far East (Vasilyeva 1998) includes "*D. concentrica*", *D. eschscholzii* (Ehrenb.) Rehm, *D. gelatinoides* Lar.N. Vassiljeva, *D. obovata* Lar.N. Vassiljeva (= *D. fissa*), and *D. occidentalis*. The specimens corresponding to *D. eschscholzii* need to be revised, while *D. gelatinoides* has very peculiar stromata similar to those found in *Entonaema*: they are internally gelatinous and filled with liquid when fresh and become hollow inside upon drying. Later, *Daldinia singularis* Y.M. Ju et al. was described (Ju et al. 1999); that species has very small stromata and seems to be restricted to *Carpinus cordata* Blume in eastern Russia.

Material and methods

The material was found by different collectors in eastern Russia. Microscopical analyses were performed using the same equipment as described by Stadler et al. (2004). The descriptions contain color codes in parentheses that follow Rayner (1970). Anamorphic structures were recorded from cultures initiated from ascospores and propagated on Difco Oatmeal agar as described by Stadler et al. (2004) using a similar methodology as that proposed by Ju et al. (1997). HPLC profiling of stromatal methanol extracts was conducted earlier as described by Stadler et al. (2006).

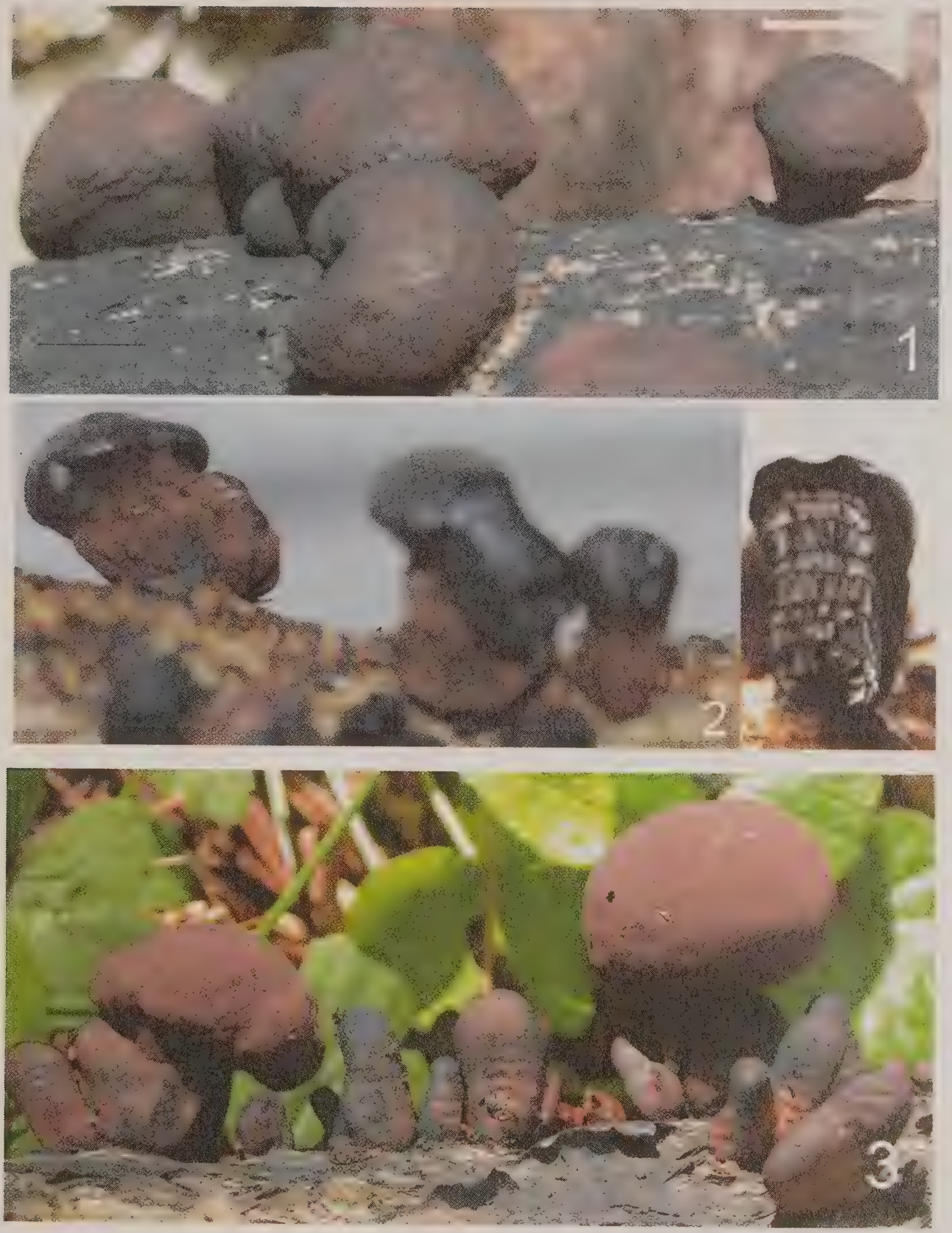

Fig. 1-3. 1 - *Daldinia childiae*, 2 - *Daldinia fissa* from eastern Russia, 3- *Daldinia carpinicola*. Scale bar for all figures = 10 mm

Taxonomic description

Daldinia carpinicola Lar.N. Vassiljeva & M. Stadler, **sp. nov.** FIG. 3
MYCOBANK MB511594

Stromata clavata, substipitata, solitaria, 0.8-1.3 cm diametro, ad 2 cm alto, externe levigata, atro-testacea vel atro-purpurina, pigmenti pallide-purpurino-grisei (115) in KOH dissoluti. Perithecia tubulosa, 0.9-1.1 mm alta, 0.2-0.3 mm crassa, textura sub peritheciis zonis atro-brunneis et pallide-brunneis alternantibus composita. Asci p. sp. 80-90 x 8-10 µm, stipitibus 100 µm longitudine, annulo apicali discoideo, in liquoure iodato Melzeri cyanescente. Ascosporae ellipsoideo-inequilaterales, brunneae vel atro-brunneae, (13)14-16.5 x (6.5)7-8(10) µm, rima germinativa recta et longa in latere convexo praeditae; perisporium in 10% KOH dehiscens.

Holotype: Russia, near Vladivostok, on dead branches of *Carpinus cordata*, 26 September 1997, Larissa Vasilyeva (VLA). Culture deposited as CBS 122880.

ETYMOLOGY: the name refers to the genus of the host plant.

Stromata clavate, with short, conical bases, usually solitary, 0.8-1.3 cm diam., up to 2 cm high, surface smooth, dark brick to vinaceous, with KOH extractable pigments mostly pale vinaceous grey (115). Perithecia tubular, 0.9-1.1 mm high, 0.2-0.3 mm wide, the tissue below consisting of alternating dark and light brown zones. Asci p. sp. 80-90 x 8-10 µm, with stalks up to 100 µm long and discoid apical ring bluing in Melzer's iodine reagent, 3.5 x 0.5 µm. Ascospores ellipsoid-inequilateral, brown to dark brown, (13)14-16.5 x (6.5)7-8(10) µm, with strait germ slit over spore length on the convex side, perispore dehiscent in 10% KOH.

ADDITIONAL SPECIMENS EXAMINED: Russia, near Vladivostok, on dead branches of *Carpinus cordata*, 5 October 2006, Larissa Vasilyeva (VLA).

DISTRIBUTION: This species is common around Vladivostok city in the Primorsky Territory of Russia, but not yet found in other areas.

COMMENTS — *Daldinia carpinicola* seems to be restricted to *Carpinus*, similar to *Daldinia singularis*, from with it deviates in having larger stromata of different shape and internal zonation, as well as in having larger ascospores and different anamorphic structures.

The teleomorphic and anamorphic characteristics of the type specimen were already illustrated as "*Daldinia* sp. from Russian Far East" (Ju et al. 1999). Its anamorphic characters in culture are similar to those of *D. decipiens* Wollw. & M. Stadler (studied first by Ju et al. 1999 for comparison with the current fungus as "*Daldinia* sp. from Denmark" and later on by Stadler et al. 2001a) and *D. petriniae* Y.M. Ju et al. (cf. Ju et al. 1997 and Petrini & Müller 1986, as "*D. occidentalis*"), and so is its HPLC profile. However, *D. decipiens* has larger ascospores and is thus far only found on different betulaceous hosts in Europe (Stadler et al. 2001a, 2004).

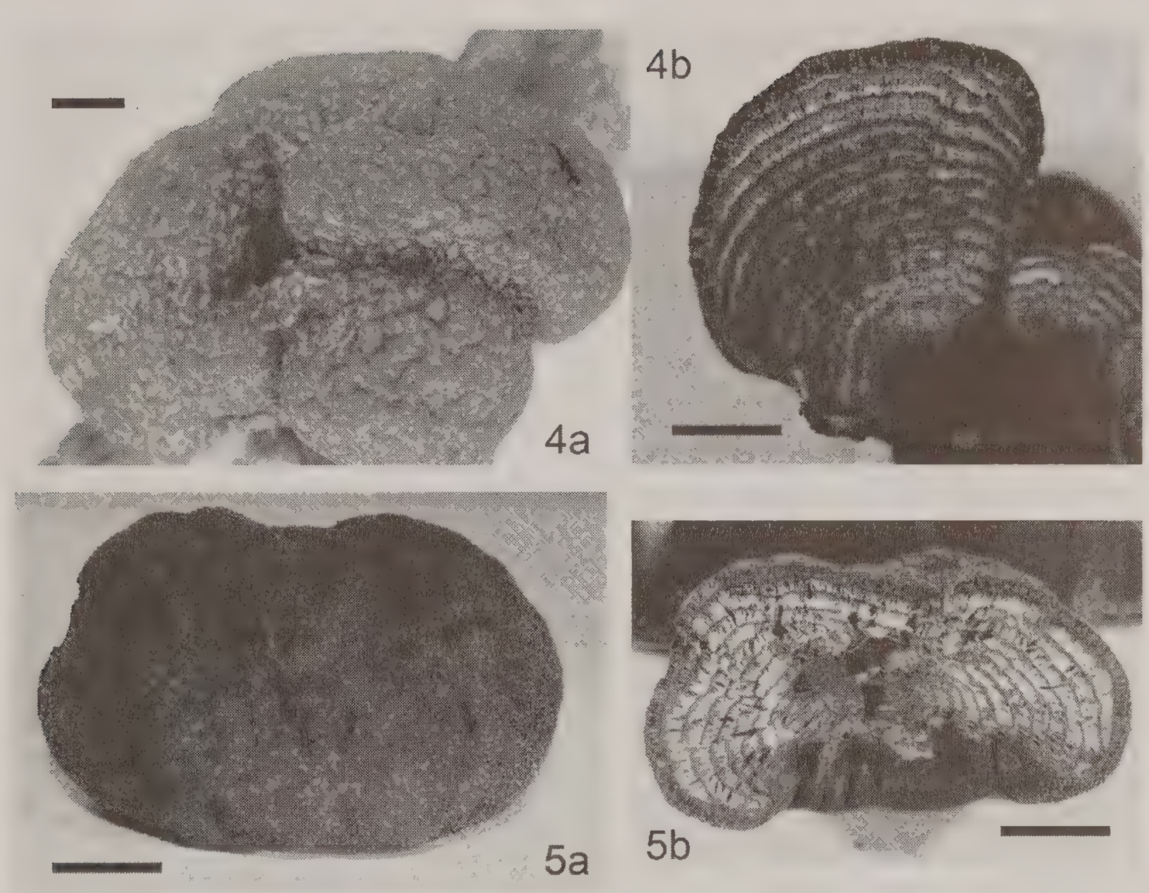

Fig. 4-5. 4 - *Daldinia barkalovii*, a - stromatal surface, b - vertical section of a stroma; 5 - *Daldinia govorovae*, a - stromatal surface, b - vertical section of as stroma. Scale bars: 4a - 5 mm, 4b - 45 mm, 5a - 85 mm, 5b - 95 mm.

Daldinia barkalovii Lar.N. Vassiljeva & M. Stadler, **sp. nov.** Figs. 4, 6c-d

MycobBank MB511595

Stromata irregulariter pulvinata, sessilia vel leviter constricta in modem basi crassati, 1.5-5 cm diametro, ad 1-1.5 cm alto, externe rugosa, atra, striis flexuosis et coffei-coloratis vel ochraceis tecta, pigmenti pallide-purpureo-grisei in KOH dissoluti. Perithecia tubulosa, ca. 0.6-0.8 mm alta, 0.2-0.3 mm crassa, textura sub peritheciis zonis atro-brunneis et pallide-brunneis alternantibus composita. Asci p. sp. 78-92 x 8-10 µm, stipitibus ad 140 µm longitudine, annulo apicali discoideo, in liquoure iodato Melzeri cyanescente. Ascosporae ellipsoideo-inequilaterales, brunneae, 12-14(15) x 6-7(7.5) µm, rima germinativa recta et longa in latere convexo praeditae; perisporium in 10% KOH dehiscens.

Holotype: Russia, Sakhalin Island, vicinity of Voskresenovka, on dead branches of *Alnus* sp., 1 August 2003, leg. Vyacheslav Barkalov (VLA). Culture deposited as CBS 116999.

Etymology: named after the Russian botanist Vyacheslav Ju. Barkalov who collected the type specimen.

Stromata irregularly cushion-shaped, sessile or slightly constricted below terminating in a wide base, 1.5-5 cm diam., 1-1.5 cm high; surface wrinkled, black, covered with wavy stripes of coffee or ochre color, KOH-extractable pigments vinaceous grey (101). Perithecia tubular, about 0.6-0.8 mm high, 0.2–0.3 mm wide, the tissue below composed of alternating dark and light brown zones, but some zones above are whitish. Asci p. sp. 78-92 x 8-10 µm, the stipe up to 140 µm long, with discoid apical ring 2.5-3 x 0.75-1 µm, bluing in Melzer's iodine reagent. Ascospores ellipsoid-inequilateral, mostly with narrowly rounded ends, brown, 12-14(15) x 6-7(7.5) µm, with straight germ slit over spore-length on the convex side, perispore dehiscent in 10% KOH.

CULTURES AND ANAMORPH: Colonies on 2% Difco Oatmeal Agar at 23°C and under 12 h fluorescent light reaching the edge of 9 cm Petri dish in 7 days, whitish, felty, azonate, with diffuse margins, becoming isabelline (65) to honey (45); reverse citrine (13), melanising with age. Sporulating regions scattered over entire surface of colony, with abundant sporulation on tufts of hyphae that become spread over entire colony as well, pale luteous (11) or fawn (87). Conidiogenous structure with *Sporothrix*-like to, much less frequently, *Nodulisporium*-like branching pattern as defined in Ju and Rogers (1996).

CONIDIOPHORES (Fig. 6c-e) mononematous, unbranched or dichotomously branched, hyaline, coarsely roughened, 2.5-3 µm diam and up to 140 µm long, with 1-3 conidiogenous cells arising from each terminus. Conidiogenous cells clavate, hyaline, roughened, 10-25 x 3-5 µm. *Conidia* produced from percurrently proliferating conidiogenous cells, hyaline, smooth, ellipsoid, usually with an attenuated flattened base, 7-10 x 5.5-7 µm. *HPLC profiles:* Stromata of *D. barkalovii* contain 4,4-4′,4′-binaphthalenetetrol (BNT) and further binaphthalene derivatives.

DISTRIBUTION: The species is only known from the type locality.

COMMENTS — *Daldinia barkalovii* is similar to *Daldinia lloydii* Y.M. Ju et al. in its unusual colored stromatal surface but with a different ornamentation (not a reticulate cracking); there are no greenish olivaceous pigments observed, and the ascospores are smaller on average [the spore size range given by Ju et al. 1997 for *D. lloydii* is actually narrower than that reported later on by Wollweber & Stadler (2001), who studied additional collections and found ascospores ranging from 12-18 x 6-8(9) µm]. Specimens of *D. petriniae* (especially those from *Alnus incana* in Europe, cf. Wollweber & Stadler 2001) have a similar ascospore size range, but differ in their stromatal morphology, lacking the conspicuous surface structure of *D. barkalovii*, and in having slightly smaller dimensions of conidia and conidiophores.

Daldinia govorovae Lar.N. Vassiljeva & M. Stadler, **sp. nov.** FIGS. 5, 6a-b
MYCOBANK MB511596

Stromata globosa vel depresso-globosa, sessilia, solitaria, circa 4.5 cm diametro, externe scabra, fusca, pigmenti inter umbrini et castanei vel sepiacei in KOH dissoluti. Perithecia tubulosa, 0.8-1.2 mm alta, circa 0.3-0.5 mm crassa, textura sub peritheciis zonae angustae et atrae zonis latis et albidis vel flavescentis alterantia, zonae latae fibrillis angustis in strato

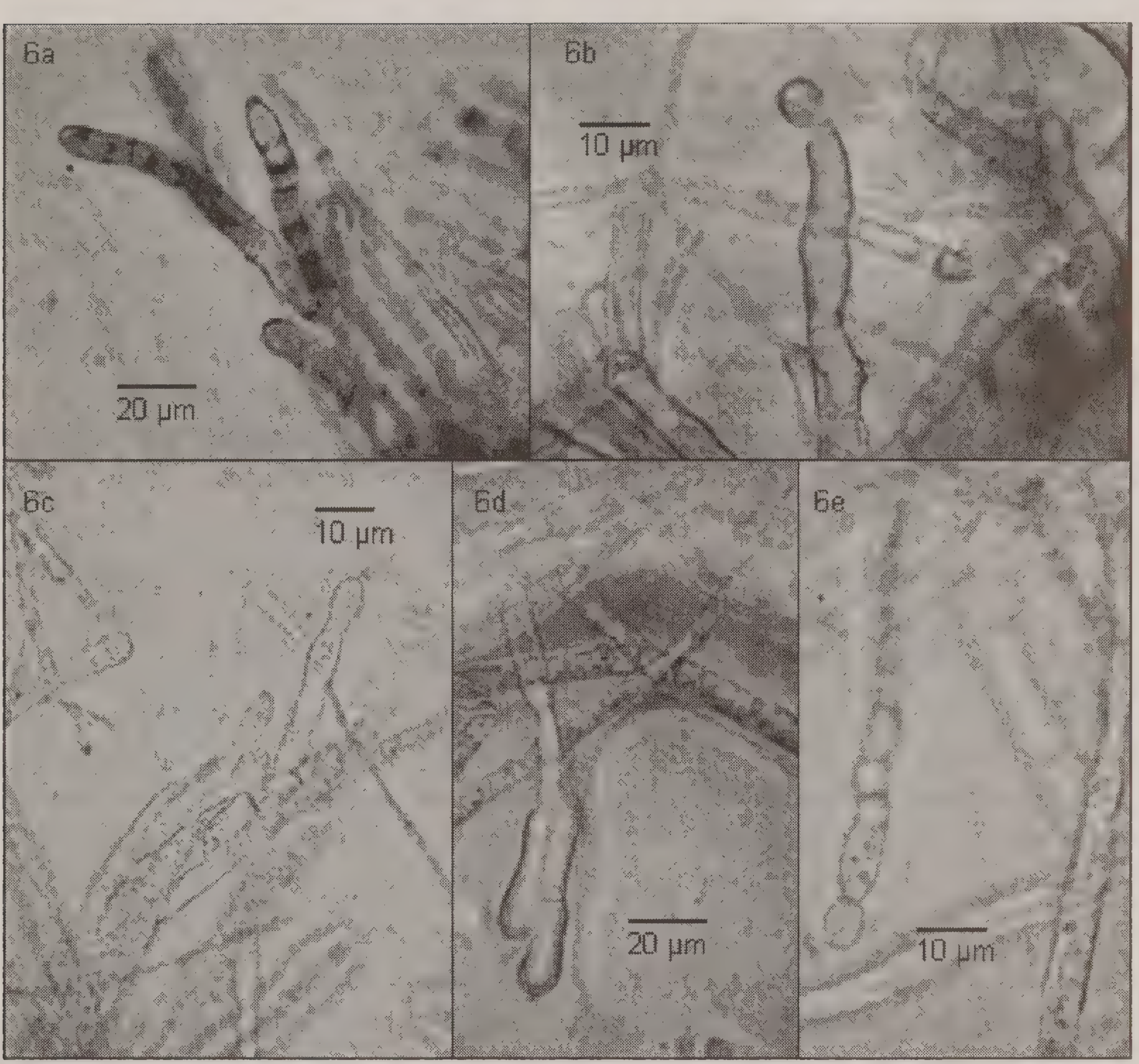

Fig. 6. Micrographs of anamorphic structures of *Daldinia* spp. (from Difco OA culture, 1000x, phase contrast). Fig. 6a-b. *Daldinia govorovae.* Branched *Sporothrix*- to *Nodulisporium*-like conidiophores (6a) and tip of *Sporothrix*-like conidiophore bearing a conidium (6b). Figs 6c-e. *Daldinia barkalovii,* 6c, d. Conidiophores and conidiogenous cells. e) tip of *Sporothrix*-like conidiophore bearing a conidium. Scales are indicated by bars.

vellaris compositae ('fissa'-type). Asci conglutinati, reactio in liquore iodato Melzeri nullo. Ascosporae ellipsoideo-inequilaterales, apices anguste-rotundae, brunneae, (15)16-18(20) x 10-12 µm, rima germinativa recta et longa in latere convexo praeditae; perisporium in 10% KOH dehiscens.

Holotype: Russia, reserve "Kedrovaya Pad", on wood of a deciduous tree, 19 September 1997, leg, Olga Govorova (VLA). Culture deposited as CBS 122883.

ETYMOLOGY: named after the Russian mycologist Olga K. Govorova who collected the type specimen.

Stromata globose or depressed-globose, sessile, solitary, up to 4.5 cm diam.; surface roughened, dark-brown, with KOH-extractable pigments between umber (9) and chestnut (40) or sepia (63), turning purplish after 5 minutes of incubation. Perithecia tubular, 0.8-1.2 mm high, about 0.3-0.5 mm wide, the tissue below composed of alternating narrow, dark-brown zones and wide, whitish or yellowish ones, the latter being a palisade of thin fibriles ('fissa-type'). Asci agglutinated, without any reaction in the presence of Melzer's ioidine reagent. Ascospores ellipsoid-inequilateral, with narrowly rounded ends, brown, (15)16-18(20) x 10-12 µm, with straight germ slit over spore-length on the convex side; perispore dehiscent in 10% KOH.

Cultures and anamorph: Colonies on 2% Difco Oatmeal Agar at 23°C and under 12 h fluorescent light reaching the edge of 9 cm Petri dish in 9-11 days, whitish to cream, felty, azonate, with diffuse margins, becoming isabelline (65) to honey (45); reverse citrine (13), melanising with age. Sporulating regions scattered over entire surface of colony, fawn (87). Conidiogenous structure with *Sporothrix*-like to *Nodulisporium*-like branching pattern as defined in Ju & Rogers (1996).

Conidiophores (Fig. 6a-b) mononematous, unbranched or dichotomously branched, hyaline, coarsely roughened, up to 210 µm high, 2.5-3.5 mm diam, with 1-3 conidiogenous cells arising from each terminus. Conidiogenous cells clavate, hyaline, roughened, 10-45 x 3.5-5.5 µm. Conidia produced from percurrently proliferating conidiogenous cells (no sympodially proliferating conidiogenous cells observed). Conidia hyaline, smooth, subglobose to obovoid, usually with an attenuated flattened base, (7-)8-11 x 6-7.5 µm.

HPLC profiles: Stromata of *D. govorovae* contain 4,4-4´,4´-binaphthalenetetrol (BNT) along with a series of hitherto unknown metabolites that were so far not observed in any other specimen of *Daldinia*. These unknown pigments appear to be responsible for the brownish pigments. Inconstant pigment reactions have been reported for some specimens of *D. petriniae* by Wollweber & Stadler (2001) and Stadler et al. (2001a). However, the metabolites involved are apparently different. Daldinal A and daldinin C, which are characteristic of the *D. childiae* group (Stadler et al. 2001d) have not been recorded in the current species, which therefore shows no chemotaxonomic affinities to any of the other species that show similar stromatal pigment colors.

Distribution: The species is only known from the type locality.

Comments — The gross stromatal morphology and anatomy are similar to *Daldinia macrospora* F. San Martín et al., but the latter is reported to have ascospores 22-30 µm long. *D. govorovae* and *D. macrospora* could be considered as vicarious species in eastern Asia and central North America. *Daldinia gelatinosa* Y.M. Ju et al., reported from North America (Ju et al. 1997) has a similar stromatal habit, but it has smaller, conspicuously acute ascospores. Whilst cultures and anamorphs of the above discussed species have never been studied, the conidiogenous structures of *D. govorovae* are similar to those of the *D. petriniae* group in that its conidiogenesis is enteroblastic. Its conidiophores are particularly robust, and its conidia are also larger than those of the presumably related taxa. These characters combined, along with the apparently specific HPLC profile, justify in our mind the erection of a new species, albeit only the type specimen has so far become available.

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Literature cited

Ablakatova AA, Protsenko AE, Protsenko EP. 1964. Mikoflora orekhoplodnykh na yuge Dalnego Vostoka [Mycoflora of nut plants in the south of Far East]. Izvestiya Akademii nauk USSR, ser. biol. 4: 606-612.

Bunkina IA, Nazarova MM. 1978. Griby [Fungi]. Flora i rastitelnost Ussuriyskogo zapovednika. Moskva: 36-104.

Dennis RWG. 1971. Some *Xylariaceae* from Soviet Far East. Zhivaya priroda Dalnego Vostoka [Living Nature of the Far East]. Tallin: 42-51.

Johannesson H, Læssøe T, Stenlid J. 2000. Molecular and morphological investigation of the genus *Daldinia* in Northern Europe. Mycological Research 104: 275-280.

Ju YM, Rogers JD. 1996. A revision of the genus *Hypoxylon*. Mycologia Memoir 20: 1-363.

Ju YM, Rogers JD, San Martín F. 1997. A revision of the genus *Daldinia*. Mycotaxon 61: 243-293.

Ju YM, Vasilyeva L, Rogers JD. 1999. *Daldinia singularis* sp. nov. from eastern Russia and notes on some other taxa. Mycotaxon 71: 405-412.

Koval EZ. 1972. Mikoflora zapovednika “Kedrovaya pad” [Mycoflora of the reserve “Kedrovaya pad”]. Flora i rastitelnost zapovednika “Kedrovaya pad”. Vladivostok: 105-144.

Koval EZ, Nelen ES. 1959. Mikoflora zelyenykh nasazhdeniy goroda Vladivostoka [Mycoflora of shade-tree plantations in Vladivostok city]. Soobshcheniya Dalnevostochnogo filiala Sibirskogo otdeleniya Akademii nauk USSR 11: 50-58.

Lyubarsky LV. 1952. Bolezni barkhata i griby-razruschiteli myertvoy drevesiny [Diseases of Amur corktree and fungi destroying dead wood]. Barkhat amursky. Moscva-Leningrad: 51-58, 135-137.

Lyubarsky LV. 1961. Vrediteli i bolezni yasenya manchzhurskogo [Pests and diseases of Manchurian ash]. Yasen manchzhursky. Khabarovsk: 42-62, 117-127.

Petersen RH, Hughes KW. 2007. Some agaric distribution patterns involving Pacific landmasses and Pacific Rim. Mycoscience 48: 1-14.

Petrini LE, Müller E. 1986. Haupt- und Nebenfruchtformen europäischer *Hypoxylon*- Arten (*Xylariaceae, Sphaeriales*) und verwandter Pilze. Mycologia Helv. 1: 501-627.

Rayner RW. 1970. A mycological colour chart. CMI, Kew. 34 p. + charts I & II.

Rogers JD, Ju YM, Watling R, Whalley AJS. 1999. A reinterpretation of *Daldinia concentrica* based upon a recently discovered specimen. Mycotaxon 72: 507-519.

Stadler M, Baumgartner M, Wollweber H, Rogers JD, Ju Y-M 2001a. *Daldinia decipiens* sp. nov. and notes on some other European *Daldinia* spp. inhabiting Betulaceae. Mycotaxon 80: 167-177.

Stadler M, Læssøe T, Simpson JA, Wollweber H. 2004. A survey of *Daldini*a species with large ascospores. Mycological Research 108: 1025-1041.

Stadler M, Quang DN, Tomita A, Hashimoto T, Asakawa Y. 2006 Production of bioactive metabolites during stromatal ontogeny of *Hypoxylon fragiforme*. Mycological Research 110: 811-820.

Stadler M, Wollweber H, Mühlbauer A, Asakawa Y, Hashimoto T, Rogers JD, Ju Y-M, Wetzstein H-G, Tichy H-V. 2001b. Molecular chemotaxonomy of *Daldinia* and other Xylariaceae. Mycological Research. 105, 1191-1205.

Stadler M, Wollweber H, Mühlbauer A, Henkel T, Asakawa Y, Hashimoto T, Rogers JD, Ju Y-M, Wetzstein H-G, Tichy H-V. 2001c. Secondary metabolite profiles, genetic fingerprints and taxonomy of *Daldinia* and allies. Mycotaxon 77: 379-429.

Tomilin BA. 1962. Griby nekotorych fitotsenozov Amurskoy pod-taygi [Fungi of some plant associations in Amur sub-taiga]. Botanichesky zhurnal 47: 1116-1125.

Tomilin BA. 1966. Novye svedeniya o sumcharykh gribakh Amurskoy oblasti [New data on ascomycetous fungi of Amur region]. Novosti sistematiki nizshikh rasteniy 3: 162-170.

Tranzschel WG. 1914. Griby i miksomitsety Kamchatki [Fungi and myxomycetes of Kamchatka]. Trudy Kamchatskoy ekspeditsii F. P. Ryabuschinskogo. T. 2. Sporovye rasteniya. Moscva: 535-576.

Vasilkov BP. 1969. Sumchatye griby (makromitsety) sovetskoy Arktiki [Ascomycetous fungi (macromycetes) of the soviet Arctic]. Mikologiya i Fitopatologiya 3: 113-120.

Vasilyeva LN. 1998. Pyrenomitsety i Lokuloaskomitsety [Pyrenomycetes and Loculoascomycetes]. In: Azbukina, Z. M. (ed.) Nizschiye rasteniya, griby i mokkhoobrazbiye Dal'nego Vostoka Rossii. IV. Sankt-Petersburg: Nauka. 419 p.

WollweberH, Stadler M. 2001. Zur Kenntnis der Gattung *Daldinia* in Deutschland und Europa. Zeitschrift für Mykologie 67: 3-53.

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A taxonomic revision of the *Ganodermataceae* reported from Taiwan

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Abstract — Previous studies of the *Ganodermataceae* in Taiwan are reviewed. A checklist of the species along with their current taxonomic status is given. Totally 31 names are included, with 26 treated in *Ganoderma*, three in *Amauroderma*, and one each in *Magoderna* and *Tomophagus*. Among them, 13 species and a variety of *Ganoderma*, two species of *Amauroderma*, one species of *Magoderna* and one species of *Tomophagus* are recognized. *Ganoderma australe* is accepted as a species complex. Two names are excluded from the *Ganodermataceae*, and 11 are currently regarded as synonyms.

Key words —East Asia, polypore, taxonomy

Introduction

Ganodermataceae Donk is a widespread polypore family, with most species distributed in the tropics. It is characterized by a coriaceous, sessile or stipitate basidioma that produces double-walled basidiospores with a yellow to brown ornamented inner layer. Several genera described in the family have been variably accepted: *Amauroderma* Murrill, *Elfvingia* P. Karst., *Ganoderma* P. Karst., *Haddowia* Steyaert, *Humphreya* Steyaert, *Magoderna* Steyaert, *Tomophagus* Murrill, and *Trachyderma* (Imazeki) Imazeki (Moncalvo & Ryvarden 1997, Kirk et al. 2001).

The first record for the *Ganodermataceae* from Taiwan dates back to Murrill (1909), who reported a collection of '*Elfvingia tornata* (Pers.) Murrill', based on one collection made by K. Miyake. Later on, several Japanese researchers published some more records of *Ganodermataceae* from Taiwan. Yasuda (1917) and Kanehira (1918, 1923) recorded two and three *Ganoderma* species respectively from Taiwan. Sawada (1931, 1934a, 1959) recognized three additional species of this genus from this region. Imazeki (1939, 1952) and Imazeki & Hongo (1957) reported six additional taxa, including four *Ganoderma* species and two new *Amauroderma* combinations. In the mid-twentieth century, Taiwanese researchers began researching this family. Hou (1950) described the new species, *Ganoderma multipileum*. Chen (1976) listed seven *Ganoderma* and one *Amauroderma* species, all previously reported from Taiwan. Further, three *Ganoderma* species new to science were described by Chang & Chen (1984), Hseu et al. (1989), and Zang & Su (1990). Chang and co-authors (Chang 1992, 1994, 1996; Chang et al. 1997, 2000, 2001; Chou & Chang 2005) reported five species and one variety of *Ganoderma* as well as one species each of *Amauroderma* and *Magoderna*. Recently, Wu & Zhang (2003) reported three species of *Ganodermataceae*, two of which are new to Taiwan. Wang et al. (2005) treated two synonyms of *G. sinense* and *G. weberianum*, based on two names presented by Chang & Chen (1984) and Hseu et al. (1989) respectively. Finally, Wang & Wu (2007) recognized two new *Ganoderma* records from Taiwan.

The following treatment lists all *Ganodermataceae* species names previously recorded from Taiwan and annotates their current taxonomic status and known habitat. Where possible, an accepted modern name is assigned for each name based on literature review and/or specimen examination. Names are arranged alphabetically by genus and species, and accepted names are printed in bold type. Examined specimens are deposited at the Herbaria of the National Taiwan Museum (TAIM), National Museum of Natural Science of ROC (TNM), and National Museum of Nature and Science in Japan (TNS).

Species

Amauroderma cf. ***exile*** (Berk.) Torrend, Broteria, Ser. Bot. 18: 142 (1920).
≡*Polyporus exilis* Berk., Hooker's J. Bot. Kew Gard. Misc. 8: 173 (1856).
≡*Fomes exilis* (Berk.) Cooke, Grevillea 13 (no. 68): 117 (1885).

Chang et al. (2000), who first reported this species from Taiwan, described the specimen as having a black, rigid pileus up to 8 cm wide and finely or inconspicuously echinulate basidiospores 6–9 × 5.5–8 µm. According to Furtado (1981), *A. exile* has a reddish brown, papyraceous to subcorky pileus (no more than 5 cm wide) and larger [7–10(–12) µm] basidiospores with conspicuous echinulae. Chang et al. (2000) mentioned that this species differs from *A. rugosum* only by having smaller basidiospores.

Habitat: on base or root of dead or withering broad-leaved trees (Chang et al. 2000).

Amauroderma rugosum (Blume & T. Nees) Torrend, Broteria, Ser. Bot. 18: 127 (1920).
≡*Polyporus rugosus* Blume & T. Nees, Nova Acta Acad. Caes. Leop.-Carol. 13: 21 (1826).
≡*Ganoderma rugosum* (Blume & T. Nees) Pat., Bull. Soc. Mycol. Fr. 5: 68 (1889).

Amauroderma rugosum is one of the most frequently cited species in *Amauroderma* (Furtado 1981). Sawada (1934a) first described this species from Taiwan, but in *Ganoderma*. The basidiospore sizes of the Taiwanese specimens examined fall within the range (8.5–14 × 7.5–11 µm).

SPECIMENS EXAMINED: **Taiwan: Taichung,** Tunghai University, 24°11′N, 120°36′E, alt. 160 m, on the ground, 17 May 2000, S.Z. Chen, *Chen 1101* (TNM F0012038); Tunghai University, 24°11′N, 120°36′E, on the ground, 21 Aug. 1994, R.L. Wang & Y.W. Pan, *Wu 9408-43* (TNM F0012038). **Pingtung,** Chufengshan, 22°04′N, 120°51′E, alt. 300 m, on soil, 24 May 1998, C.C. Wen & S.Z. Chen, *CWN 03361* (TNM F0011163).

Habitat: on base or root of dead broad-leaved trees (Chang et al. 2000), e.g., *Acacia confusa* (Sawada 1934a, 1942; Chou & Chang 2005), or on the ground (Wu et al. 1996, 2002).

Amauroderma scopulosum (Berk.) Imazeki, Bull. Gov. Forest Exp. St. Tokyo 57: 99 (1952).
≡*Polyporus scopulosus* Berk., Hooker's J. Bot. Kew Gard. Misc. 6: 143 (1854).
≡*Trametes scopulosus* (Berk.) Bres., Hedwigia 31: 317 (1912).

Imazeki (1952) recorded this species from Taiwan, meanwhile published its new combination in *Amauroderma*. Ryvarden (1991) treated it as *Trametes scopulosus* (Berk.) Bres., i.e. not a member of *Ganodermataceae*.

Elfvingia tornata (Pers.) Murrill, Bull. Torrey Bot. Club 30 (5): 301 (1903).
≡*Polyporus tornatus* Pers., in de Freycinet, Voy. Uranie. Bot. 5: 173 (1827).

Synonymous with *Ganoderma australe* (Humphrey & Leus 1931, Steyaert 1975, Moncalvo & Ryvarden 1997, Smith & Sivasithamparam 2003). See under *G. australe*.

Fomes annularis Lloyd, Mycol. Writ. 4 (Letter 40): 6 (1912).

Sawada (1959) first reported this name from Taiwan. The Taiwanese collection has a campanulato-ungulate basidiocarp with a thick crust, 14 cm high and 17 cm broad at the bottom, a blackish brown pilear surface, and thin chestnut brown context (Sawada 1959). Ryvarden (1989) regarded this taxon as a synonym of *Ganoderma australe*. See under *G. australe*.

Fomes leucophaeus (Mont.) Cooke, Grevillea 14 (no. 69): 18 (1885).
≡*Polyporus leucophaeus* Mont., Syll. Crypt.: 157 (1856).

Kanehira (1918) first recorded this name from Taiwan but without providing a description or specimen citation. This taxon is often treated as a synonym

(Humphrey & Leus 1931, Chen 1976) or variety (Humphrey & Leus 1931) of *Ganoderma applanatum*. However, the distribution of *G. applanatum* has been questioned in Taiwan. See under *G. applanatum*.

Fomes nigrolaccatus (Cooke) Cooke, Grevillea 14 (no. 69): 18 (1885).
≡*Polyporus nigrolaccatus* Cooke, Grevillea 9 (no. 51): 97 (1881).

This name was first reported from Taiwan by Yasuda (1917). The sessile rigid basidiocarp, grey pileus with laccate substances on the surface, small pores, and ovoid basidiospores 9 × 6 µm (Yasuda 1917), is reminiscent of *Ganoderma fornicatum*.

Ganoderma applanatum (Pers.) Pat., Hyménomyc. Eur. (Paris): 143 (1887).
≡*Boletus applanatus* Pers., Observ. Mycol. (Lipsiae) 2: 2 (1800) ['1799'].
≡*Polyporus applanatus* (Pers.) Wallr., Fl. Crypt. Germ. (Nürnberg) 2: 591 (1833).
≡*Fomes applanatus* (Pers.) Gillet, Hyménomycètes (Alençon): 686 (1878).
≡*Elfvingia applanata* (Pers.) P. Karst., Bidr. Känn. Finl. Nat. Folk 48: 334 (1889).

This species has been recorded under *Fomes applanatus* (Kanehira 1923, Sawada 1931), *Ganoderma applanatum* (Sawada 1934a, 1942), and *Elfvingia applanatus* (Chen 1976). Based on our survey, however, Taiwanese collections identified as this species appear to represent either *G. applanatum* var. *laevisporum* or the *G. australe* complex.

Ganoderma applanatum var. ***laevisporum*** Humphrey & Leus-Palo, Philipp. J. Sci., C, Bot. 45: 533 (1931).

This variety was found at the higher elevations in the tropics, with mature spores lacking echinulation (Humphrey & Leus 1931). Chang (1994) recorded it from Taiwan.

Habitat: on dead trunks of hardwoods (Chang 1994).

Ganoderma australe (Fr.) Pat., Bull. Soc. Mycol. Fr. 5: 71 (1889).
≡*Polyporus australis* Fr., Elench. Fung. (Greifswald) 1: 108 (1828).
≡*Fomes australis* (Fr.) Cooke, Grevillea 14 (no. 69): 18 (1885).
=*Elfvingia tornata* (Pers.) Murrill, Bull. Torrey Bot. Club 30 (5): 301 (1903).
=*Fomes annularis* Lloyd, Mycol. Writ. 4 (Letter 40): 6 (1912).

MISAPPLIED:
Fomes leucophaeus (Mont.) Cooke (Kanehira 1918: 88).
Fomes applanatus (Pers.) Gillet (Kanehira 1923: 15).
Ganoderma applanatum (Pers.) Pat. (Sawada 1934: 450).
Elfvingia applanata (Pers.) P. Karst. (Chen 1976: 130).

Murrill (1909) first reported this species under *Elfvingia tornata*. Later, this species was also reported under several other names, such as *Fomes leucophaeus* (Kanehira 1918), *Ganoderma applanatum* (Sawada 1934a), or *Fomes annularis*

(Sawada 1959). Kanehira (1923) first applied the epithet '*australis*' to the Taiwanese collection. Yeh & Chen (1990) separated *G. australe* collections into two intersterility groups, one with an average growth rate at the optimum temperature range of 28–32 °C of 6.2 mm/day, and the other with an average growth rate at the optimum temperature range of 24–28 °C of 4.0 mm/day. The two groups proved to be genetically distinct, as evidenced by PCR-RFLP analysis (Yeh et al. 1995) or DNA sequencing (Chang et al. 1996). This suggests that the Taiwanese *G. australe* represents two distinct species. The correct names for the two species have yet to be determined, however. For the time being, we refer to *G. australe* as a species complex.

Habitat: on broad-leaved trees (Wu et al. 1996, 2002), e.g., *Acacia confusa*, *Fagaceae*, *Delonix regia*, *Eriobotrya japonica*, *Pittosporum formosanum*, *Livistona chinensis* (Yeh & Chen 1990).

Ganoderma boninense Pat., Bull. Soc. Mycol. Fr. 5: 72 (1889).
≡*Fomes lucidus* f. *boninensis* Pat. ex Sacc., Syll. Fung. (Abellini) 6: 157 (1888).

Chang (1992) first reported this species from Taiwan.

Habitat: on stems of broad-leaved trees (Chou & Chang 2005), e.g., *Fagaceae* and *Casuarina*. (Chang 1992).

Ganoderma calidophilum J.D. Zhao, L.W. Hsu & X.Q. Zhang, Acta Microbiol. Sin. 19: 270 (1979).

Chou & Chang (2005) recently recorded this species from Taiwan. Their description corresponds to that provided for the holotype (Zhao et al. 1979). However, they did not provide data on the basidiospore size and did not cite a voucher specimen. *Ganoderma flexipes* is morphologically very similar to *G. calidophilum* in having a thin and long stipe, and small-sized reddish brown pileus. The relationships between these two species need to be clarified.

Habitat: on base of bamboo (Chou & Chang 2005).

Ganoderma camphoratum M. Zang & C.H. Su [as '*comphoratum*'], Acta Bot. Yunn. 12 (4): 395 (1990).

Not a member of *Ganodermataceae*. Wu et al. (1997) transferred it to *Antrodia* P. Karst., based on morphological study. Later, Wu et al. (2004) established a new genus, *Taiwanofungus* Sheng H. Wu et al. for it, according to morphological study and molecular analysis.

Ganoderma densizonatum J.D. Zhao & X.Q. Zhang, in Zhao et al., Acta Mycol. Sin. 5 (2): 86 (1986).

Wu & Zhang (2003) reported this record from Taiwan. This study examined the only cited specimen, *Chen 946* (TNM F0010592), and determined it as

G. fornicatum. *Ganoderma densizonatum* probably represents a synonym of *G. fornicatum*.

Specimen examined: **Taiwan: Taitung**, Orchid Island, along the road to Tienchih, on angiosperm wood, 22°01′N, 121°34′E, alt. 50 m, 24 Oct. 1999, S.Z. Chen, *Chen 946* (TNM F0010592).

Ganoderma flexipes Pat., Bull. Soc. Mycol. Fr. 23: 75 (1907).
≡*Fomes flexipes* (Pat.) Sacc. & Traverso, Syll. Fung. (Abellini) 19: 710 (1910).
≡*Polyporus flexipes* (Pat.) Lloyd, Mycol. Writ. 3 (Syn. Stip. Polyporoids): 104 (1912).

A recently recorded species from Taiwan (Wang & Wu 2007).

Ganoderma formosanum T.T. Chang & T. Chen, Trans. Br. Mycol. Soc. 82 (4): 731 (1984).

Chang & Chen (1984) described this new species from Taiwan. It is a synonym of *G. sinense* (Wang et al. 2005). See under *G. sinense*.

Ganoderma fornicatum (Fr.) Pat., Bull. Soc. Mycol. Fr. 5: 71 (1889).
≡*Polyporus fornicatus* Fr., Linnaea 5: 516 (1830).

Imazeki (1939) first recorded this species from Taiwan. We examined the only cited Taiwanese collection, TNS-F-201259. It has a small-sized, rigid basidiocarp with a dorso-lateral but missing stipe, slightly laccate, black, strongly sulcate, somewhat radially rugose pileus, yellowish brown to brown context, pale brown pore surface with minute pores, and ellipsoid basidiospores 11–13 × 6.5–7.5 µm. These characteristics are very similar to the descriptions of Lloyd (1912) based on the authentic material of *G. fornicatum* collected from type locality.

Specimen examined: **Taiwan: Taipei**, Urai, Dec. 1908, S. Kusano, *201.259* (TNS-F-201259).

Habitat: on angiosperm wood (Wu & Zhang 2003).

Ganoderma japonicum (Fr.) Sawada, Rep. Gov. Res. Inst. Dep. Agric. Formosa 51: 76 (1931).
≡*Polyporus japonicus* Fr., Epicr. Syst. Mycol. (Upsaliae): 442 (1838).

Sawada (1931) applied this name to some Taiwanese collections. The morphology of *G. japonicum* described by Sawada (1931), is similar to those of *G. multipileum* or *G. flexipes*. These collections may represent *G. multipileum* or *G. flexipes*.

Habitat: on dead bamboo, e.g., *Bambusa stenostachya* (Sawada 1931).

Ganoderma limushanense J.D. Zhao & X.Q. Zhang, Acta Mycol. Sin. 5 (4): 219 (1986).

The description of the Taiwanese collection (Chang 1992) corresponds with that of *G. limushanense* (Zhao & Zhang 1986), except for slightly smaller basidiospores. We cultivated the species to obtain fruiting body (culture

BCRC 35295, isolated from the specimen TFRI-58 cited in Chang (1992)). The basidiocarp, except for the dull pileus is morphologically more similar to *G. weberianum* than *G. limushanense*. The ITS sequence of the culture BCRC 35295 (data not shown) suggests that it should be re-identified as *G. weberianum*.

Habitat: on dead *Fagaceae*. (Chang 1992).

Ganoderma lucidum (Curtis) P. Karst., Revue Mycol., Toulouse 3 (9): 17 (1881).
≡*Boletus lucidus* Curtis, Fl. Londin.: 72 (1781).
≡*Polyporus lucidus* (Curtis) Fr., Syst. Mycol. (Lundae) 1: 353 (1821)
≡*Fomes lucidus* (Curtis) J. Kickx f., Fl. Crypt. Flandres 2: 238 (1867).

Yasuda (1917) first applied this name to a Taiwanese collection. Later, this name became widely accepted in Taiwan. However, *G. multipileum* is the correct name for Taiwanese '*G. lucidum*'. The details will be formally presented in a forthcoming paper.

Habitat: on base or root of dead, wounded or living trees, mostly on broad-leaved trees (Chang et al. 2000), e.g., *Acacia confusa* (Sawada 1934b, Chang 1991), *Albizia lebbeck* and *Delonix regia* (Sawada 1934b).

Ganoderma microsporum R.S. Hseu, in Hseu et al., Mycotaxon 35 (1): 36 (1989).

Hseu et al. (1989) described this new species from Taiwan. It is a synonym of *G. weberianum* (Wang et al. 2005). See under *G. weberianum*.

Ganoderma multipileum **Ding Hou [as '*multipilea*'], Quart. J. Taiwan Mus. 3: 101 (1950).**

New species of *Ganoderma* described from Taiwan (Hou 1950).

SPECIMENS EXAMINED: **Taiwan: Taichung,** By Taichung Park, on stump, 7 Sep. 1949, Y.F. Yu (TAIMF000001 – holotype); National Chunghsing University, 24°07′N, 120°41′E, on trunk of *Delonix regia*, 5 Sep. 2003, M.C. Fan & S.A. Liu, *FL0309-1* (TNM F0015492); National Museum of Natural Science, 24°10′N, 120°39′E, alt. 100 m, on trunk of *D. regia*, 23 Sep. 1995, W.N. Chou, *CWN 01269* (TNM F0004355).

Habitat: on base or root of *Acacia confusa* (Chang & Chen 1986, Chang 1991), *D. regia* (this study).

Ganoderma multiplicatum (Mont.) Pat., Bull. Soc. Mycol. Fr. 5: 74 (1889).
≡*Polyporus multiplicatus* Mont., Annls Sci. Nat., Bot., sér. 4, 1: 128 (1854).
≡*Fomes multiplicatus* (Mont.) Cooke, *Grevillea* 14 (no. 69): 18 (1885).

A recently recorded species from Taiwan (Wang & Wu 2007).

Ganoderma rotundatum J.D. Zhao, L.W. Hsu & X.Q. Zhang, Acta Microbiol. Sin. 19: 267 (1979).

Wu & Zhang (2003) recorded this species from Taiwan.

Habitat: on butt of *Acacia confusa* (Wu & Zhang 2003).

Ganoderma sinense J.D. Zhao, L.W. Hsu & X.Q. Zhang, Acta Microbiol. Sin. 19: 272 (1979).

=*Ganoderma formosanum* T.T. Chang & T. Chen, Trans. Br. mycol. Soc. 82 (4): 731 (1984).

The correct name for *G. formosanum* (Wang et al. 2005). A Taiwanese collection in TNS herbarium, TNS-F-201589, originally determined as *G. japonicum* by R. Kanehira and later redetermined as *G. lucidum* by R. Imazeki, is found to be *G. sinense* in this study.

SPECIMEN EXAMINED: **Taiwan: Nantou,** 16 Mar. 1918, R. Kanehira, TNS-F-201589.

Habitat: on base of *Liquidambar formosana* (Chang & Chen 1984).

Ganoderma tropicum (Jungh.) Bres., Annls Mycol. 8 (6): 586 (1910).

≡*Polyporus tropicus* Jungh., Praem. Fl. Crypt. Java: 63 (1838).
≡*Fomes tropicus* (Jungh.) Cooke, Grevillea 14 (no. 69): 19 (1885).

Imazeki (1939) first reported this species from Taiwan with *G. lucidum* sensu Sawada (1934a) as a synonym. The collections named *G. tropicum* by Imazeki (1939) might encompass different species because several unreliable characters were used for identification, e.g., context color, distribution, and host. Two specimens cited in Imazeki (1939) were examined: TNS-F-201962 appears to include both *G. multipileum* and *G. tropicum* basidiomata; TNS-F-201210, which is immature, may represent *G. tropicum*.

SPECIMEN EXAMINED: **Taiwan: Taichung,** National Museum of Natural Science, 24°10′N, 120°39′E, alt. 100 m, on base of *Delonix regia*, 30 Jun. 1995, W.N. Chou, *CWN 01023* (TNM F0003842). **Nantou,** Puli Christian Hospital, on trunk of *Machilus zuihoensis*, 22 Jul. 2004, S.H. Wu et al., *Wu 0407-2* (TNM F0017073). **Chiayi,** July 1916, K. Sasaki, *201.962d*, TNS-F-201962 (TNS-F-201962 with 4 basidiocarps, 201.962a-d; basidiocarp 201.962a-c reidentified as *G. multipileum*).

Habitat: on base or root of dead, wounded or living trees, mostly on broad-leaved trees (Chang et al. 2000), e.g., *Acacia confusa* (Imazeki 1939, Chang 1991), *Delonix regia* and *Machilus zuihoensis* (this study).

Ganoderma tsugae Murrill, Bull. Torrey Bot. Club 29: 601 (1902).

Imazeki & Hongo (1957) first reported this species from Taiwan. It grows on high mountains in Taiwan (Chou & Chang 2005).

Habitat: on rotten wood in conifer forests (Imazeki & Hongo 1957, Chou & Chang 2005), e.g., *Tsuga chinensis* (Chou & Chang 2005).

Ganoderma tsunodae (Yasuda ex Lloyd) Trotter, Syll. Fung. (Abellini) 23: 402 (1925).

≡*Polyporus tsunodae* Yasuda ex Lloyd, Mycol. Writ. 5: 792 (1918).
≡*Elfvingia tsunodae* (Yasuda ex Lloyd) Imazeki, Bull. Tokyo Sci. Mus. 6: 102 (1943).
≡*Trachyderma tsunodae* (Yasuda ex Lloyd) Imazeki, Bull. Gov. Forest Exp. St. Tokyo 57: 97 (1952).

Imazeki (1939) first recorded this species from Taiwan, followed by Sawada (1942). Currently, the systematic position of this species is still controversial. Imazeki (1939) established *Trachyderma*, a new subgenus of *Ganoderma* based on this taxon. This treatment was accepted by Zhao & Zhang (2000). Later, this taxon was transferred to *Elfvingia* (Imazeki 1943), or raised to generic rank (Imazeki 1952); however, the genus is an illegitimate later homonym of the lichen genus, *Trachyderma* Norman. Further study is required to determine the generic placement for this species.

Habitat: on *Fagus crenata* (Sawada 1942).

Ganoderma weberianum (Bres. & Henn. ex Sacc.) Steyaert, Persoonia 7 (1): 79 (1973).
≡*Fomes weberianus* Bres. & Henn. ex Sacc., Syll. Fung. (Abellini) 9: 174 (1891).
≡*Polyporus weberianus* (Bres. & Henn. ex Sacc.) Trotter, Syll. Fung. (Abellini) 23: 383 (1925).
=*Ganoderma microsporum* R.S. Hseu, in Hseu et al., Mycotaxon 35 (1): 36 (1989).

Chang et al. (1997) first recorded *G. weberianum* from Taiwan by describing the cultural characteristics. Chang et al. (2001) provided the morphological description of this species. A purplish blue stain is often observed on pileus upper surface and stipe of this species. Chlamydospores are also present in context and culture.

Habitat: on stem base or root of conifers and broad-leaved trees (Chou & Chang 2005), e.g., *Salix babylonica* (Hseu et al. 1989), *Acacia confusa* (Chang et al. 1997, Chou & Chang 2005), *Ficus microcarpa* and *Araucaria cunninghamii* (Chang et al. 2001, Chou & Chang 2005), *Casuarina equisetifolia* and *Salix warburgii* (Chou & Chang 2005).

Magoderna subresinosum (Murrill) Steyaert, Persoonia 7 (1): 112 (1973).
≡*Fomes subresinosus* Murrill, Bull. Torrey Bot. Club 35: 410 (1908).

This is the type species for the genus, *Magoderna*. Chang (1996) first reported this species from Taiwan.

Habitat: on stems of hardwoods (Chang 1996), e.g., *Machilus zuihoensis* (Chang et al. 2000, Chou & Chang 2005).

Tomophagus colossus (Fr.) Murrill, Torreya 5: 197 (1905).
≡*Polyporus colossus* Fr., Nova Acta Regiae Soc. Sci. Upsal., Ser. 3, 1: 56 (1851).
≡*Ganoderma colossus* (Fr.) C.F. Baker, Fungi malayenses no. 425 (1918).

This is the type species for the monotypic *Tomophagus*. Chang et al. (2001) first recorded it as *Ganoderma colossus* from Taiwan. Wu & Zhang (2003) accepted *Tomophagus* as a distinct genus based on peculiar morphology of this species. Its generic placement in *Tomophagus* was also supported by molecular evidences (Moncalvo et al. 1995, Hong & Jung 2004).

Habitat: on rotten coffin made of *Cunninghamia lanceolata* (Wu & Zhang 2003).

Conclusions

Among the 31 names cited for Taiwan representatives of the *Ganodermataceae*, the 18 accepted taxa include 13 species and one variety of *Ganoderma* (*G. applanatum* var. *laevisporum*, *G. australe*, *G. boninense*, *G. calidophilum*, *G. flexipes*, *G. fornicatum*, *G. multipileum*, *G. multiplicatum*, *G. rotundatum*, *G. sinense*, *G. tropicum*, *G. tsugae*, *G. tsunodae*, and *G. weberianum*), two *Amauroderma* species (*A.* cf. *exile* and *A. rugosum*), *Magoderna subresinosum*, and *Tomophagus colossus*. Two names — *Amauroderma scopulosum* and *Ganoderma camphoratum* — are excluded from the *Ganodermataceae*. Nine names — *Elfvingia tornata*, *Fomes annularis*, *F. leucophaeus*, *F. nigrolaccatus*, *Ganoderma applanatum*, *G. densizonatum*, *G. japonicum*, *G. limushanense*, *G. lucidum* — are treated as synonyms in this paper, while two others — *Ganoderma formosanum*, *G. microsporum* — were previously recognized as synonyms.

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Literature cited

Chang CY, Yeh ZY, Lee-Chen GJ. 1996. Analysis of genetic diversity of two intersterility groups of *Ganoderma australe* by DNA sequencing. Biol Bull NTNU 31: 47–53.

Chang TT. 1991. Comparison of basidiocarp morphology and pure culture between *Ganoderma lucidum* and *Ganoderma tropicum*. Bull Taiwan For Res Inst, New Series 6: 397–406. (in Chinese)

Chang TT. 1992. One terrestrial and some lignicolous *Aphyllophorales* (*Basidiomycotina*) from Taiwan. Bot Bull Acad Sin 33: 327–334.

Chang TT. 1994. Some new Taiwan Polypores (*Basidiomycotina*). Trans Mycol Soc R.O.C. 9: 111–122.

Chang TT. 1996. Nine species of polypores new to Taiwan. Fungal Sci 11: 31–38.

Chang TT, Chen T. 1984. *Ganoderma formosanum* sp. nov. on Formosan sweet gum in Taiwan. Trans Br Mycol Soc 82: 731–733.

Chang TT, Chen T. 1986. Studies on nuclear behavior, mating type and heterokaryosis of several species of *Ganoderma* in Taiwan. Plant Prot Bull 28: 231–240. (in Chinese)

Chang TT, Chiu WH, Hua J. 1997. The cultural Atlas of wood-inhabiting *Aphyllophorales* in Taiwan. Vol. 2. Mycol Monogr 11. Hsinchu, Taiwan: Food Industry Research and Development Institute. 118 pp.

Chang TT, Chou WN, Wang YZ, Zhu YM. 2001. Macrofungi of Taiwan. Taipei, Taiwan: Council of Agriculture, Executive Yuan R.O.C. 542 pp. (in Chinese)

Chang TT, Chou WN, Wu ML, Wang YZ. 2000. Macrofungi in Fushan. Taipei, Taiwan: Council of Agriculture, Executive Yuan R.O.C. 195 pp. (in Chinese)

Chen ZC. 1976. Notes on new Formosan forest fungi V. A list of *Polyporaceae* found in Taiwan. Taiwania 21: 128–133.

Chou WN, Chang TT. 2005. Mushrooms of Taiwan. Taipei, Taiwan: Yuanliu Press. 439 pp. (in Chinese)

Furtado JS. 1981. Taxonomy of *Amauroderma* (*Basidiomycetes*, *Polyporaceae*). Mem New York bot Gard 34: 1–109.

Hong SG, Jung HS. 2004. Phylogenetic analysis of *Ganoderma* based on nearly complete mitochondrial small-subunit ribosomal DNA sequences. Mycologia 96: 742–755.

Hou D. 1950. A new species of *Ganoderma* from Taiwan. Q J Taiwan Mus 3: 101–105.

Hseu RS, Chen ZC, Wang HH. 1989. *Ganoderma microsporum*, a new species on weeping willow in Taiwan. Mycotaxon 35: 35–40.

Humphrey CJ, Leus S. 1931. A partial revision of the *Ganoderma applanatum* group, with particular reference to its oriental variants. Philipp J Sci, C, Bot. 45: 483–589.

Imazeki R. 1939. Studies on *Ganoderma* of Nippon. Bull Tokyo Sci Mus 1: 29–52. (in Japanese)

Imazeki R. 1943. The genera of *Polyporaceae* of Nippon. Bull Tokyo Sci Mus 6: 1–111. (in Japanese)

Imazeki R. 1952. A contribution to the fungous flora of Dutch New Guinea. Bull Govt For Exp Sta 57: 87–128.

Imazeki R, Hongo T. 1957. Coloured illustrations of fungi of Japan. 1. Osaka, Japan: Hoikusha Publishing Co. 181 pp. (in Japanese)

Kanehira R. 1918. Fungi collected in tentana, Hsinchu. Trans Nat Hist Soc Formosa no.36, 88. (in Japanese)

Kanehira R. 1923. Mushroom of Taiwan (3). Trans Nat Hist Soc Formosa 64: 15–16. (in Japanese)

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th ed. Wallingford, UK: CAB International.

Lloyd CG. 1912. Mycological Writings. 3: 102–109.

Moncalvo JM, Ryvarden L. 1997. A nomenclatural study of the *Ganodermataceae* Donk. Synop Fung 11. Oslo, Norway: Fungiflora. 114 pp.

Moncalvo JM, Wang HF, Wang HH, Hseu RS. 1995. The use of ribosomal DNA sequence data for species identification and phylogeny in the *Ganodermataceae*. In: Buchanan PK, Hseu RS, Moncalvo JM. (Eds.), *Ganoderma: Systematics, Phytopathology and Pharmacology.* Proceedings of Contributed Symposium 59A, B, 5th International Mycological Congress, Vancouver, August 14-21, 1994, pp. 31–44. Taipei, Taiwan: National Taiwan University.

Murrill WA. 1909. *Polyporaceae* from Japan. Mycologia 1: 164–170.

Ryvarden L. 1989. Type studies in the *Polyporaceae* - 21. Species described by C.G.Lloyd in *Cyclomyces, Daedalea, Favolus, Fomes* and *Hexagonia.* Mycotaxon 35: 229–236.

Ryvarden L. 1991. Genera of Polypores. Nomenclature and taxonomy. Synop Fung 5. Oslo, Norway: Fungiflora. 363 pp.

Sawada K. 1931. Descriptive catalogue of Taiwan (Formosan) fungi. Pt. V. Special Publ Coll Agric Natl Taiwan Univ 131 pp. (in Japanese)

Sawada K. 1934a. Materials of the Formosan fungi (32). Trans Nat Hist Soc Formosa 24: 450–460.

Sawada K. 1934b. Materials of the Formosan fungi (31). Trans Nat Hist Soc Formosa 24: 298–307.

Sawada K. 1942. Descriptive catalogue of Taiwan (Formosan) Fungi. Pt. VII. Special Publ Coll Agric Natl Taiwan Univ 159 pp.

Sawada K. 1959. Descriptive catalogue of Taiwan (Formosan) fungi. Pt. XI. Special Publ Coll Agric Natl Taiwan Univ 268 pp.

Smith BJ, Sivasithamparam K. 2003. Morphological studies of *Ganoderma* (*Ganodermataceae*) from the Australasian and Pacific regions. Aust Syst Bot 16: 487–503.

Steyaert RL. 1975. The concept and circumscription of *Ganoderma tornatum*. Trans Br Mycol Soc 65: 451–467.

Wang DM, Wu SH. 2007. Two species of *Ganoderma* new to Taiwan. Mycotaxon 102: 373–378.

Wang DM, Zhang XQ, Yao YJ. 2005. Type studies of some *Ganoderma* species from China. Mycotaxon 93: 61–70.

Wu SH, Chou WN, Wang YZ. 1996. Higher fungi of Taiwan – to understand *Ascomycota* and *Basidiomycota*. Taichung, Taiwan: Natl Mus Nat Sci Press. 204 pp. (in Chinese)

Wu SH, Chou WN, Wang YZ. 2002. Higher fungi of Taiwan – to understand *Ascomycota* and *Basidiomycota*. 2nd ed. Taichung, Taiwan: Natl Mus Nat Sci Press. 216 pp. (in Chinese)

Wu SH, Ryvarden L, Chang TT. 1997. *Antrodia camphorata* ("niu-chang-chih"), new combination of a medicinal fungus in Taiwan. Bot Bull Acad Sin 38: 273–275.

Wu SH, Yu ZH, Dai YC, Chen CT, Su CH, Chen LC, Hsu WC, Hwang GY. 2004. *Taiwanofungus*, a polypore new genus. Fungal Sci 19: 109–116.

Wu SH, Zhang XQ. 2003. The finding of three *Ganodermataceae* species in Taiwan. Coll and Res 16: 61–66.

Yasuda A. 1917. Fungi of Taiwan. Scientific world 15: 11–18. (in Japanese)

Yeh ZY, Chang CY, Lee-Chen GJ. 1995. Genetic diversity of two intersterility groups of *Ganoderma australe* in Taiwan. Biol Bull NTNU 30: 117–124.

Yeh ZY, Chen ZC. 1990. Preliminary investigations of *Ganoderma australe* (Subgen. *Elfvingia*) in Taiwan. Taiwania 35: 127–141.

Zang M, Su CH. 1990. *Ganoderma comphoratum*, a new taxon in genus *Ganoderma* from Taiwan, China. Acta Bot Yunn 12: 395–396. (in Chinese)

Zhao JD, Xu LW, Zhang XQ. 1979. Taxonomic studies of the subfamily *Ganodermatoideae* of China. Acta Microbiol Sin 19: 265–279. (in Chinese)

Zhao JD, Zhang XQ. 1986. Studies on the taxonomy of *Ganodermataceae* in China V. Acta Mycol Sin 5: 219–225. (in Chinese)

Zhao JD, Zhang XQ. 2000. Flora Fungorum Sinicorum. 18: *Ganodermataceae*. Beijing, China: Science Press. 204 pp. (in Chinese)

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Conidial fungi from the semi-arid Caatinga biome of Brazil. *Brachysporiellina fecunda* sp. nov. and some new records for Neotropica

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Abstract — *Brachysporiellina fecunda* is described and illustrated based on specimens collected on decaying leaves in the State of Bahia and Pernambuco. It is distinguished by the other species of *Brachysporiellina* in producing polyblastic conidiogenous cells with 4-15 conspicuous denticles and 4-septate conidia with conico–truncate bases.

Key words — litter fungi, systematics, semi-arid fungi, hyphomycetes

Introduction

During several expeditions since 2005 through the "Caatinga" biome, a characteristic vegetation of the semi-arid region of Brazil, some interesting conidial fungi were collected. One of these is proposed as a new species, and is described and illustrated.

The monotypic genus *Brachysporiellina* Subram. & Bhat was proposed based on a single species *B. pulneyensis*, collected from the dead stem of an unidentified plant in South India (Subramanian & Bhat 1989). It is characterized by the presence of conidiophores with apical and internodal polyblastic conidiogenous cells with conspicuous denticles, with rhexolytic secession and acrogenous, 3-septate conidia. According to these authors the denticles at nodes retain remnants of "separating cells" a feature unique to the genus. *Brachysporiella* Bat. is the most similar genus, but the conidial secession is schizolytic (Batista 1952). The present specimen shows remarkable differences from previously described hyphomycetes. It is distinguished from *B. pulneyensis* in producing polyblastic conidiogenous cells with 4–15 conspicuous denticles and 4-septate conidia with conico–truncate bases. On the basis of these distinct features it is therefore described as a new species.

Materials and methods

Samples of litter plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dish moist chambers at 25° C, in plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of × 1000.

Taxonomy

Brachysporiellina fecunda S.M. Leão, A.C. Cruz, R.F. Castañeda, & Gusmão **anam. sp. nov.** **Figs. 1-5**

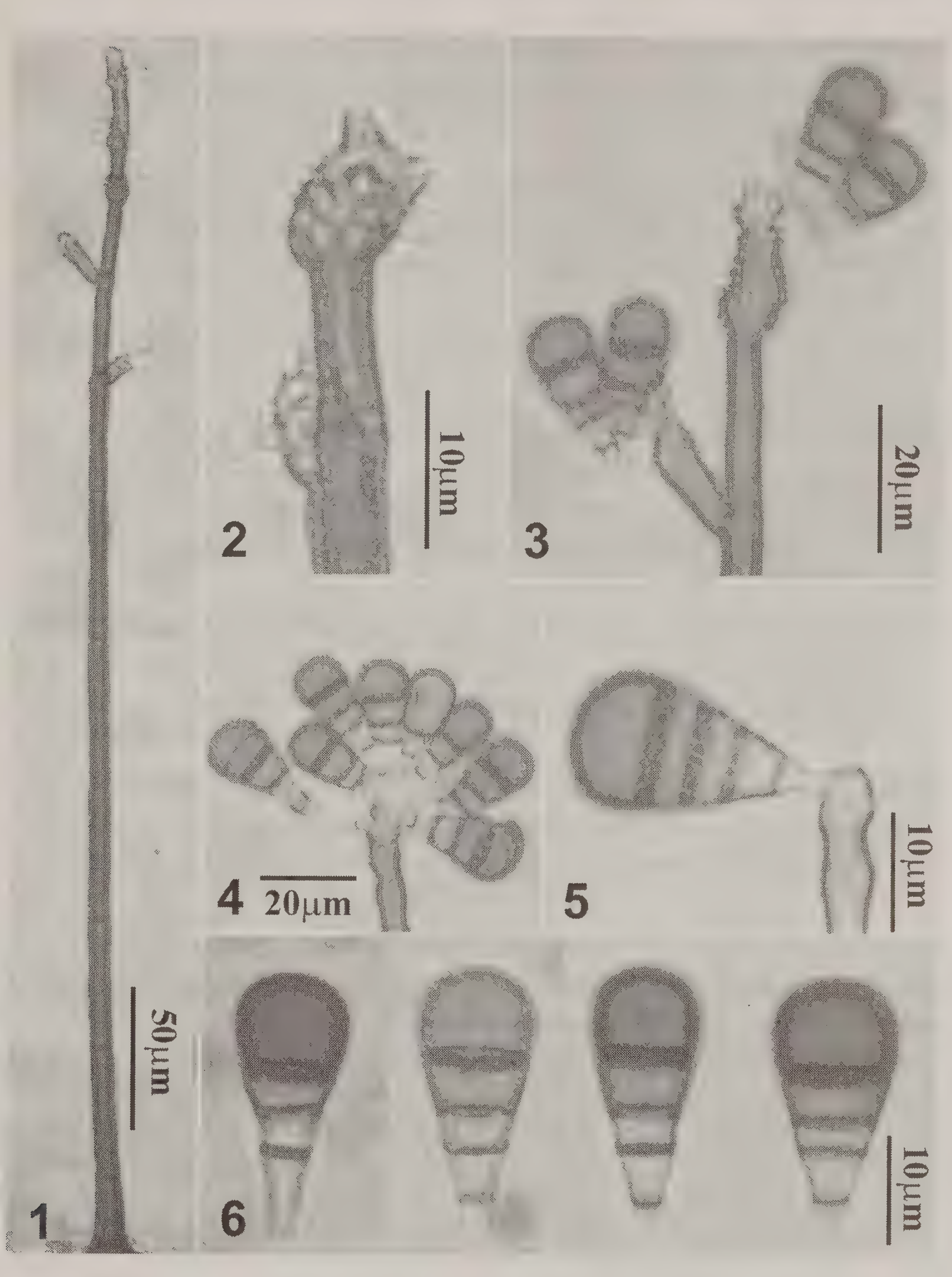
MycoBank MB 510882

Conidiophora macronemata, mononemata, simplicia vel ramosa, erecta, recta vel flexuosa, laevia, septata, brunnea, 130–605 × 15–14 µm, ad apicem 5–12.5 µm. Cellulae conidiogenae polyblasticae, integratae, terminales vel intercalares, sympodiales, denticulatae, laeves, pallide brunneae vel brunneae, 6.5–21×3–6 µm; ad apicem 4–6 µm; denticuli 2–5 × 1.5–2 µm; Conidia rhexolytice secedentia, solitaria, acropleurogena, obpyriformia ad usque turbinata, rotundata ad apicem, conicotruncata ad basim, laevia, (3) 4-septata, brunnea, 18–35 × 9–17 µm, ad basim 3–5 µm. Teleomorphosis ignota.

Holotypus: HUEFS120866. **BRAZIL. Bahia: Senhor do Bonfim**, on dead leaves of unidentified dicotyledonous plant, 10.X.2006, coll. S.M. Leão-Ferreira.

Etymology: Latin, *fecundus,* in reference to the numbers of denticles on the conidiogenous cells.

Conidiophores macronematous, mononematous, simple or branched, erect, straight or flexuous, smooth, septate, brown, 130–605 × 15–14 µm; apex 5–12.5 µm. Conidiogenous cells polyblastic, integrated, terminal and intercalary, sympodial, denticulate, smooth, pale brown to brown, 6.5–21 × 3–6 µm; apex 4–6 µm; denticles 2–5 × 1.5–2 µm. Conidial secession rhexolytic.



Figs. 1-5. *Brachysporiellina fecunda*, from holotype (HUEFS120866).
Fig. 1. Conidiophore. **Fig. 2.** Conidiogenous cells and denticles. **Fig. 3, 4.** Conidia attached to conidiogenous cells. **Fig. 5.** Detail of conidium and conidiogenous cell. **Fig. 6.** Conidia.

CONIDIA solitary, acropleurogenous, obpyrifom to turbinate, rounded at apex, conico–truncate at bases, smooth, (3-) 4–septate, basal cells pale brown, apical cells brown, 18–35 × 9–17 µm; base 3–5 µm. TELEOMORPH unknown.

ADDITIONAL SPECIMEN EXAMINED: **BRAZIL. PERNAMBUCO, Buíque,** on dead leaves of unidentified dicotyledonous plant, 04.IX.2006, coll. A.C.R. Cruz. HUEFS123351.

New records for Brazil, South America and Neotropica

Endophragmiella rigidiuscula R.F. Castañeda, Fungi Cubensis III (La Habana): 9. 1988.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha,** Serra da Jibóia, on decaying leaves of *Andira fraxinifolia* Benth., S. M. Leão-Santos, 05.IV.2005, HUEFS 98004.

Dendryphiella vinosa (Berk. & M.A. Curtis) Reisinger, Bull. Trimest. Soc. Mycol. Fr. 84(1): 27. 1968.

Specimen examined: **BRAZIL. Rio Grande do Norte: Seridó,** on decaying leaves of unidentified dicotyledonous plant, S. M. Leão-Santos, 20.X.2006, HUEFS 114792.

Sarcopodium circinatum Ehrenb., Sylv. Mycol. Berol. (Berlin): 23. 1818.

Specimens examined: **BRAZIL. Bahia: Pilão Arcado,** "Dunas do São Francisco", on decaying leaves of unidentified dicotyledonous plant, S.M. Leão-Santos,12. XII.2005. HUEFS105760; **Pernambuco: Buíque,** on decaying leaves of unidentified dicotyledonous plant, S.M. Leão-Santos, 01.III.2006. HUEFS105763.

Stachybotrys globosa P.C. Misra & S.K. Srivast., Trans. Br. Mycol. Soc. 78(3): 556. 1982.

Specimen examined: **BRAZIL. Rio Grande do Norte: Seridó,** on decaying leaves of unidentified dicotyledonous plant, 18.IV.2006, coll. S.M. Leão-Santos. HUEFS105746.

Stachybotrys verrucispora Matsush., Matsush. Mycol. Mem. 4: 18. 1985.

Specimen examined: **BRAZIL. Rio Grande do Norte: Seridó,** on decaying leaves of unidentified dicotyledonous plant, 26.IV.2006, coll. S.M. Leão-Santos. HUEFS105764.

Acknowledgements

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Literature cited

Batista AC. 1952. Dois novos gêneros de fungos imperfeitos. Boletim da Secretaria de Agricultura, Indústria e Comércio do Estado de Pernambuco 19 (1-2): 106-111.

Subramanian CV, Bhat DJ. 1989. Hyphomycetes from South India I. Some new taxa. Kavaka 15(1-2): 41-74.

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A re-evaluation of *Cystoderma luteohemisphaericum*

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Abstract — *Cystoderma luteohemisphaericum* is revised based on type studies, examination and phylogenetic analysis of recent material from South America. The new combination, *Cystolepiota luteohemisphaerica,* is proposed. This is the first published record of this species from Ecuador and Brazil

Key words — *Agaricales,* nrITS, nrLSU sequences

Introduction

Dennis (1961) described a new agaric species, *Cystoderma luteohemisphaericum,* from coastal Venezuela. This species is characterized by rather small basidiomes, deep yellow colour of the pileus and tiny inamyloid spores. Later it was reported from Ghana in West Africa by Pegler (1968) and re-published from Venezuela by Dennis (1970). *Cystoderma* Fayod species described from tropical regions were briefly reviewed in Saar & Læssøe (2006). Harmaja (2002) combined the species in *Cystodermella*, without referring to the type material or studying it. The status of *Cystodermella* and its relationship with *Cystoderma* will be discussed in a future publication by Saar et al. .

Here a specimen of *Cystoderma luteohemisphaericum* collected by the second author and co-workers in coastal Ecuador, on rich soil in association with other lepiotoid fungi, was studied and sequenced. While in the field a striking similarity with members of *Cystolepiota* Singer was noted, e.g. free lamellae and the co-occurrence of other *Agaricaceae* rather than with a lower pH loving assemblage of macrofungi where *Cystoderma* species tend to occur (Saar and Læssøe, pers. obs.). It was identified as *Cystoderma luteohemisphaericum* based on the striking colouration, the granulose covering and the tiny basidiospores (2.8–3.8 × 1.7–2.6 μm).

Methods

The colours of the basidiocarps were designated using the colour names by Kornerup & Wanscher (1974). Microscopic investigations were carried out using a Zeiss Axioskop 2 light microscope at magnification x1000. The measurements were made in Melzer's reagent with AxioVision 3.0 software (Carl Zeiss Vision GmbH). The spore measurements are based on 110 randomly chosen basidiospores from five specimens (25 spores per each four and 10 spores per one specimen). Colour photographs of the sequenced specimen can be found at the homepage of the fungi of Ecuador (http://www.mycokey.com/Ecuador.html).

The abbreviations of herbaria are used according to the Index Herbariorum (Holmgren & Holmgren, 1998).

Genomic DNA was extracted with High pure PCR template preparation kit (Roche Applied Science) following the protocol of the manufacturer. PCR amplification was accomplished with the primer pairs ITS1F-ITS4 and LR0R-LR7 (http://www.biology.duke.edu/fungi/mycolab/primers.htm) for the nuclear ITS and partial LSU regions, respectively. PCR was performed using illustra puReTaq Ready-To-Go™ PCR Beads (GE Healthcare), followed purification with Exo-SAP (GE Healthcare) according to the manufacturer's instructions. The sequences were obtained by Macrogen Inc. (Seoul, Korea) using primers ITS5, ITS2, LR3R (http://www.biology.duke.edu/fungi/mycolab/primers.htm) and CTB6, TW13 (http://mollie.berkeley.edu/~bruns/tour/primers.html).

Sequence fragments were inspected and assembled using Sequencher 4.7 (Gene Codes). DNA sequences were submitted to the European Molecular Biology Laboratory (EMBL) database under accession numbers AM946477 (ITS) and AM946476 (LSU). Alignments were performed using L-INS-i strategy as implemented in MAFFT 6.240 (Katoh et al. 2005).

Phylogenetic analyses were performed separately for the LSU and ITS datasets. Maximum parsimony (MP) analyses were conducted in PAUP* 4.0b10 (Swofford 2002) using 1000 heuristic searches with random taxon addition sequences, TBR branch swapping, Maxtrees set to 10000, the restriction to save 100 trees in each replicate applied. Followed by initial swapping of the resulted trees. The confidence of branching was assessed using bootstrap re-sampling (bs): 1000 replicates, each with 10 random taxon addition sequences and MulTrees off. All characters were treated as unordered, equally weighted, treating gaps as missing data.

Bayesian inference of phylogeny was performed with MrBayes 3.1.2 (Ronquist & Huelsenbeck 2003) applying for both datasets the GTR + I + G DNA substitution model chosen by AIK information criterion in program MrModeltest 2.2 (Nylander 2004). The Markov chains Monte Carlo (MCMC) were run with 2M generations for both datasets, and with default values for other prior settings. According to the specified generations the first 200K generations without reaching a stable likelihood score were discarded, leaving 36 002 trees for computing the consensus trees and Bayesian posterior probability (pp) values.

Results

A comparison with the obtained sequences and sequences in public sequence databases (NCBI) using BLASTn revealed that *C. luteohemisphaericum* does not belong in *Cystoderma*. The closest matches of both ITS and LSU sequences were with sequences from the genus *Cystolepiota*.

The ITS dataset comprises 19 taxa and has an aligned length of 696 characters, with 302 constant, 109 parsimony-uninformative, and 285 parsimony-informative characters. Parsimony analysis of this dataset resulted in one equally most parsimonious tree (length = 691, CI = 0.590, RI = 0.575); the only tree with the likelihood value (– ln L = 5684.07865) is depicted as a phylogram (Fig. 1).

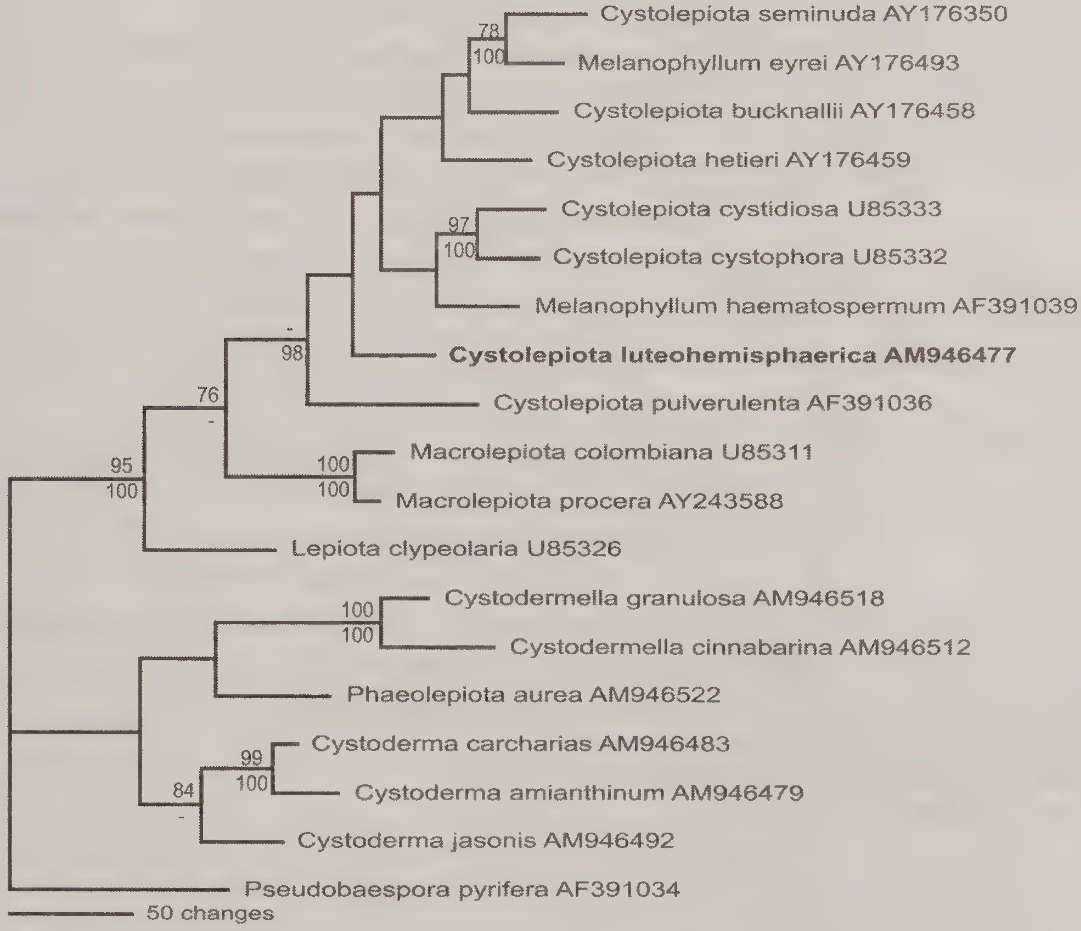
Cystolepiota seminuda AY176350
78
100
Melanophyllum eyrei AY176493
Cystolepiota bucknallii AY176458
Cystolepiota hetieri AY176459
Cystolepiota cystidiosa U85333
97
100
Cystolepiota cystophora U85332
Melanophyllum haematospermum AF391039
-
98
Cystolepiota luteohemisphaerica AM946477
Cystolepiota pulverulenta AF391036
76
-
95
100
Macrolepiota colombiana U85311
100
100
Macrolepiota procera AY243588
Lepiota clypeolaria U85326
100
100
Cystodermella granulosa AM946518
Cystodermella cinnabarina AM946512
Phaeolepiota aurea AM946522
99
100
Cystoderma carcharias AM946483
84
-
Cystoderma amianthinum AM946479
Cystoderma jasonis AM946492
Pseudobaespora pyrifera AF391034
50 changes

Fig 1. Phylogeny of *Cystolepiota luteohemisphaerica* inferred from parsimony analysis of ITS sequence data. Bootstrap support (≥ 70%) and posterior probabilities (≥ 95%) are shown above and below branches (bs/pp), respectively.

The LSU dataset comprises 23 taxa and has an aligned length of 1103 characters, with 831 constant, 99 parsimony-uninformative, and 173 parsimony-informative characters. Parsimony analysis of this dataset resulted in 7 equally most parsimonious trees (length = 588, CI = 0.608, RI = 0.636); the best tree with the smallest likelihood value (– ln L = 4380.32208) is depicted as a phylogram (Fig. 2).

The phylogenetic analyses of the ITS and partial LSU regions, as expected based on field and morphological observations, revealed that *Cystoderma luteohemisphaericum* does not belong in *Cystoderma*. The sequences of both regions consolidated into the resolved lineage with the representatives of genus *Cystolepiota* (Figs. 1 & 2).

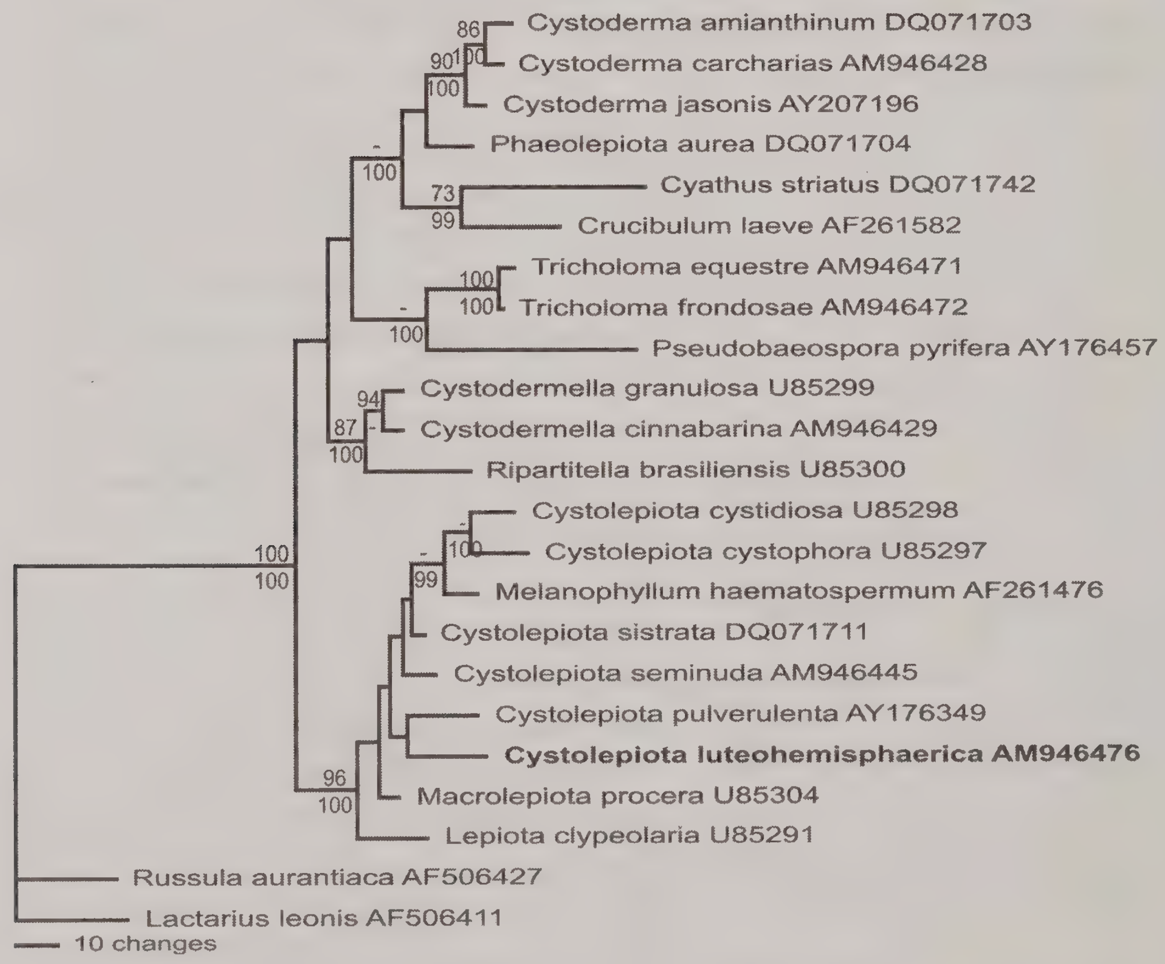
86
Cystoderma amianthinum DQ071703
90
100
Cystoderma carcharias AM946428
100
Cystoderma jasonis AY207196
Phaeolepiota aurea DQ071704
-
100
73
Cyathus striatus DQ071742
99
Crucibulum laeve AF261582
100
Tricholoma equestre AM946471
100
Tricholoma frondosae AM946472
-
100
Pseudobaeospora pyrifera AY176457
94
Cystodermella granulosa U85299
87
-
Cystodermella cinnabarina AM946429
100
Ripartitella brasiliensis U85300
Cystolepiota cystidiosa U85298
-
100
Cystolepiota cystophora U85297
100
100
-
99
Melanophyllum haematospermum AF261476
Cystolepiota sistrata DQ071711
Cystolepiota seminuda AM946445
Cystolepiota pulverulenta AY176349
Cystolepiota luteohemisphaerica AM946476
96
100
Macrolepiota procera U85304
Lepiota clypeolaria U85291
Russula aurantiaca AF506427
Lactarius leonis AF506411
10 changes

Fig 2. Phylogeny of the species *Cystolepiota luteohemisphaerica* inferred from parsimony analysis of LSU sequence data. Bootstrap support (≥ 70%) and posterior probabilities ((≥ 95%) are shown above and below branches (bs/pp).

Description of species

Cystolepiota luteohemisphaerica (Dennis) I. Saar & Laessøe, **comb. nov.** **Fig. 3**
MycoBank MB 511599

Basionym: *Cystoderma luteohemisphaericum* Dennis, Kew Bull. 15(1): 109. 1961.
Cystodermella luteohemisphaerica (Dennis) Harmaja, Karstenia 42(2): 46. 2002.

The macro-morphological description is mostly based on the specimen (TL-11724) collected by the second author, but brief descriptions of other collections were also used.

Pileus 7–20 mm, conical to irregularly applanate, dry, micaceous-mealy, somewhat radially veined; margin non-striate and faintly appendiculate with veil remnants when young; yellow (4A6-7 to 3/4A7). Lamellae free, very crowded (L 36, 1 to 7), wavy, at first white, later pale (dull) yellow (3A3), at age wax yellow (3A5); edge entire. Stipe 20–40 × 1 mm, cylindrical, rather stiff, with a white hairy ring around the base, yellowish flocculose in a helical or ring pattern; annular zone high, indistinct, above annular zone pruinose; top 3A5 (wax yellow), downwards brownish (6D5), with white rhizoids. Context was not observed; the type specimen: yellow in pileus, brown in stipe (Dennis 1961: 109); yellowish in pileus, unchanging, in stipe similar with surface (K (M) 154327). Odour recorded as absent in TL-11724 but as strongly of meal in K (M) 154326 or as without odor or weakly of 'Milton' brand disinfectant, stronger when crushed, in K (M) 154327. Taste mild.

Basidiospores (2.5–)2.8–3.8(–4.0) × (1.6–)1.7–2.6(–2.8) (mean of 110 spores: 3.3 × 2.2) μm, Q = (1.1–)1.2–1.8(–1.9) (mean: 1.5), broadly ellipsoid, ellipsoid to oblong (ovoid), hyaline, inamyloid, cyanophilous, metachromatic. Basidia clavate, hyaline, inamyloid, 4-spored, 13.2–18.6 × 4.9–5.8 μm. Pleuro- and cheilocystidia absent. Pileipellis with a covering formed by chains of sphaerocysts, 18.2–23.9 × 19.7–29.8 μm, globose to oblong, faintly rugulose, hyaline in KOH. Stipitipellis covered in globose, thin-walled sphaerocysts. Clamp connections present.

Habitat in groups on bare soil, under grass or bushes; the type specimen was recorded as gregarious on garden soil (Dennis 1961), and, although, not on garden soil, the recently collected Ecuadorian material occurred in a fairly big group on very rich, disturbed soil along a road in disturbed semideciduous coastal forest.

Collections examined – Brazil, Paraná State, Marumbi Parque, native forest, 22 Jan 1992, A. De Meijer 2107 (BR Myc 013457-71).

Ecuador, prov. Los Rios, EET Pichilingue, on soil, beneath *Theobroma cacao,* 16 Jun 1977, D.K. Cranshaw 57 (K (M) 154325); prov. Manabí, Río Ayampe, near the village (01°40'870"S 80°48'152"W), on soil, alt. 45 m, 31 Jul 2004, T. Læssøe, K. Hansen, J.H. Petersen & A. Alsgård TL-11724 (QCNE (M) 3382, C).

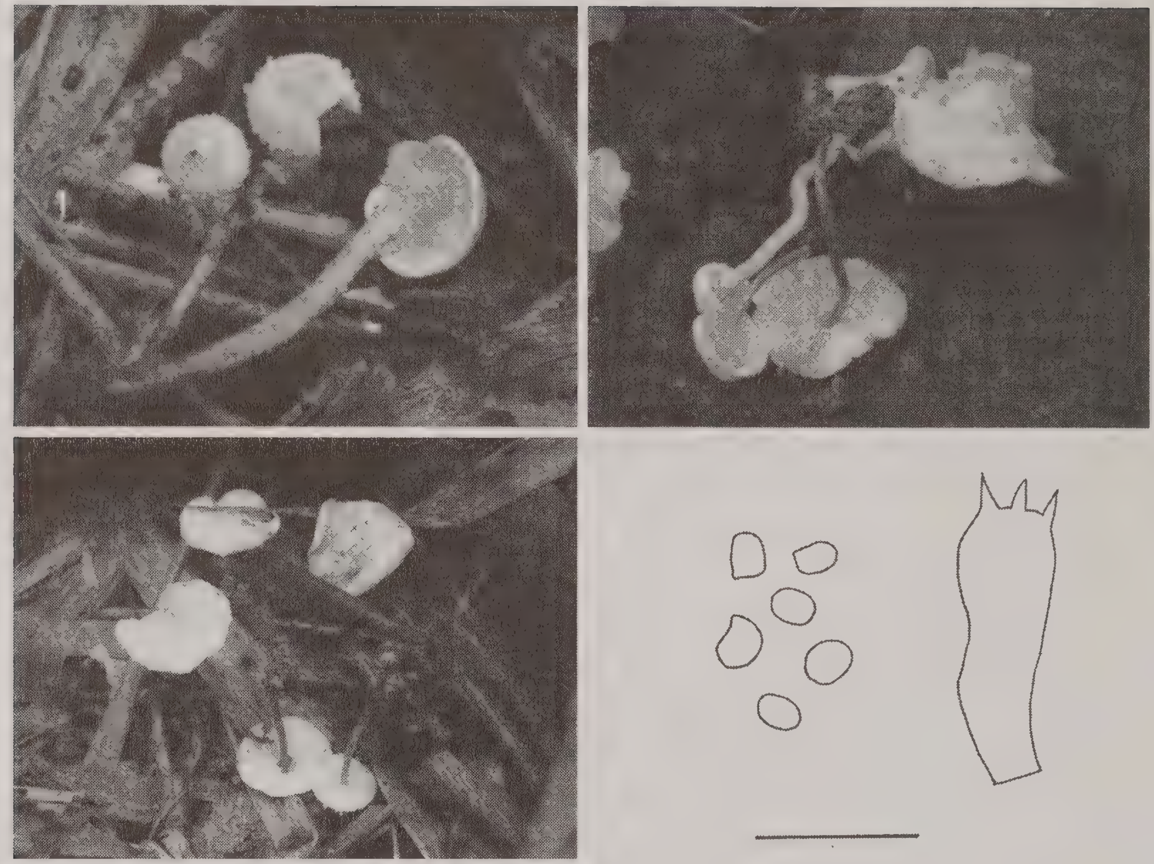

Fig 3. Ecuadorian material of *Cystolepiota luteohemisphaerica* (TL-11724). Bar = 10 µm.

Ghana, Tafo, among grass, 5 Aug 1955, M. Holden GC93 (K (M) 154326); Cape Coast, Cape Coast to Jukwa Road (app. 9 miles), scattered on bare soil, below dense thicket, 11 Jun 1975, A.C. Rose CC7559 (K (M) 154327).

Venezuela, Caracas, Botanical Garden, on bare soil, under tall grass, alt. 900 m, 19 Jun 1958, R.W.G. Dennis 1066 (K (M) 140604, **holotype**).

Comments. Dennis (1961) described the lamellae as adnate, but otherwise the Ecuadorian specimen (TL-11724) agrees in all details with the type specimen. Unfortunately, the attachment types of lamellae for other collections are not mentioned in the descriptions. The spores of the type are reported as somewhat smaller (2.5 × 2 µm) than in other specimens investigated, but due to the poor condition the first author failed in measuring any spores from this material. Only 10 spores were measured from the BR collection.

Two specimens (K (M) 140604 (holotype), and K (M) 154326) are illustrated in Dennis (1961: 108; 1970: Tab 10, f. 18) and Pegler (1968: 500), respectively. The figure in Dennis (1970) is coloured with a rather striking contrast between a yellow pileus and a more rusty stipe with paler floccules from veil; the lamellae are depicted as pale citrine seen from the side on a cut specimen – corresponding to rather mature specimens in the Ecuadorian material. Pegler's illustrations only cover microscopical features.

Dennis (1961) noticed a general resemblance, apart from colour, to *Cystolepiota seminuda* (Lasch) Bon, but referred the species to *Cystoderm*a because he judged the lamellae to be attached and the stipe as well the pileus are clothed with sphaerocysts. Actually, the presence of sphaerocysts on pilei- and stipitipellis is characteristic for the majority of *Cystolepiota* species (Vellinga 1992).

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Literature cited

Dennis RWG. 1961. Fungi Venezuelani: IV. Kew Bull. 15(1): 67-156.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull., Addit. Ser. 3: 1-531, 15 col. pls., 9 b&w pls.

Harmaja H. 2002. *Amylolepiota*, *Clavicyb*e and *Cystodermella*, new genera of the *Agaricales*. Karstenia 42(2): 39-48.

Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>.

Katoh K, Kuma K, Toh H, Miyata T. 2005. MAFFT version 5: improvement in accuracy of multiple sequence alignment. Nucleic Acids Res. 33: 511-518.

Kornerup A, Wanscher JH. 1974. Farver i farver. Politikens Forlag: København. 248 pp.

Nylander JAA. 2004. MrModeltest v2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.

Pegler DN. 1968. Studies on African *Agaricales* I. Kew Bull. 21: 499-533.

Ronquist F, Huelsenbeck JP. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19(12): 1572-1574.

Saar I, Læssøe T. 2006. New *Cystoderma* species from high Andean Ecuador. Mycotaxon 96: 123-127.

Swofford DL. 2002. PAUP*: Phylogenetic analysis using parsimony (* and other methods). Version 4.0 beta. Sinauer Associates, Sunderland.

Vellinga EC. 1992. Notulae ad floram agaricinam neerlandicam XVIII. Some notes on *Cystolepiota* and *Lepiota*. Persoonia 14(4): 407-415.

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Bresadola's polypore collection at the Natural History Museum of Trento, Italy 2

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Abstract — The revision of the 238 exsicates of Platter Herbarium's polypores, another collection of Giacomo Bresadola also kept at the herbarium of the Natural History Museum of Trento (TR) was done. The supposedly lost holotype of *Ganoderma aurantiacum* was found and the new combination *Amauroderma aurantiacum* is proposed.

Key words — *Ganodermataceae*, taxonomy

Introduction

The revision of the polypore collection of Bresadola deposited at TR was started on 2004 (Gibertoni et al. 2006) and is now being concluded. In a previous paper (Gibertoni et al. 2006), the 735 exsiccates studied represented 237 species and included the supposedly lost holotypes of *Favolus balansae* Bres. and *Polyporus hypomiltinus*. Also, parts of the types of *Polyporus flavidus* Peck. and *P. bartholomaei* were recovered and the combination *Perenniporia bartholomaei* (Peck) Gibertoni & Bernicchia was proposed (Gibertoni et al. 2006). *Polyporus flavidus* Peck was mistakenly listed as an unpublished name (Gibertoni et al. 2006); it was, however, validly published by Peck (1874: 68) but is illegitimate as a later homonym of *Polyporus flavidus* Berk.

Another set of Bresadola's specimens deposited at TR (known as the "Platter Herbarium") was organised by the Gruppo Micologico "G. Bresadola" of

Trento. In this work we have revised these exsiccates and provided taxonomic solutions.

Results

The polypore collection of the "Platter Herbarium" at TR consists of 238 exsiccates (http://www.mtsn.tn.it/bresadola/platter.asp), 55 of which were microscopically analysed; the rest represented common polypores that did not require detailed studies. The holotype of *Ganoderma aurantiacum* was discovered among the exsiccates and a new combination based on it is proposed:

Amauroderma aurantiacum (Torrend) Gibertoni & Bernicchia, **comb. nov.**
MycoBank MB511308
Bas.: *Ganoderma aurantiacum* Torrend, Iconogr. Mycol. **21**: 1007 (1932) (Holotypus: TR, B5332, Goiás, Brazil)
= *Amauroderma macrosporum* J.S. Furtado, Revis. Gên. Amauroderma: 203 (1968)

Torrend described this species in Bresadola's Iconografia Mycologica, but Furtado (1981) could not locate the type or authentic specimen during his revision of the genus *Amauroderma*. With only the description and illustration of the species available, Furtado suggested that the species belonged to *Amauroderma*. Among the species of *Amauroderma* treated by Furtado (1981), only *A. macrosporum* fitted Torrend's description. Furtado stated that if the type specimen of *G. aurantiacum* should ever be located, it would be possible that *A. macrosporum* might be displaced. Moncalvo & Ryvarden (1997) later suggested that, if the type could not be located, the name *Ganoderma aurantiacum* should be abandoned as a nomen confusum.

The label of the exsiccate B5332 of Bresadola's collection at TR contains the following:

> "*Ganoderma* (*Amauroderma*) *aurantiacum* Torrend n. sp.; hyphae hym. irregul. crassiusculae vel tenues tunicatae 2-9 μ, sporae luteae, regulares, subechinulatae, 15-19 = 14-16 μ, Brasilia, Gojaz 1927 nº 1, Leg. Torrend".

The material consists of 2 basidiomata in good condition that were macro- and microscopically examined and showed to be identical to the holotype of *A. macrosporum* (SP47598), originally collected in the city of São Paulo in 1960. *Ganoderma aurantiacum* was collected in the Brazilian State of Goiás (Gojaz), but no precise date or location was indicated.

Four other specimens have been recently collected in the State of Rondônia, in the Brazilian Amazonia, and deposited in URM (78847, 78848, 78849, 78850). After comparison with the holotypes of *A. macrosporum* and *G. aurantiacum*, a specimen previously collected in the Brazilian State of Sergipe and determined as *A. macrosporum* (Gibertoni et al. 2004) was re-identified as *A. calcigenum* (Berk.) Torrend, while other material collected in the State of Pará (Sotão et al. 1997) was re-identified as *A. schomburgkii* (Mont. & Berk.) Torrend. *Amauroderma aurantiacum* (as *A. macrosporum*) has also been reported from Venezuela (Ryvarden & Iturriaga 2001).

Acknowledgements

We would like to thank Dr. Erast Parmasto and Dr. Mario Rajchenberg for critically reviewing the manuscript, Marco Floriani (Gruppo Micologico "G.Bresadola" di Trento), and Dr. Francesco Rigobello (curator of TR) for helping the first author with the exsiccates.

Literature cited

Furtado JS. 1981. Taxonomy of *Amauroderma* (*Basidiomycetes*, *Polyporaceae*). Memoirs of the New York Botanical Garden 34: 1-109.

Gibertoni TB, Bernicchia A, Ryvarden L. 2006. Bresadola's polypore collection at the Natural History Museum of Trento, Italy. Mycotaxon 97: 1-4.

Gibertoni TB, Ryvarden L, Cavalcanti MAC. 2004. Poroid fungi (*Basidiomycota*) of the Atlantic Rain Forest in Northeast Brazil. Synopsis Fungorum 18: 33-43.

Moncalvo JL, Ryvarden L. 1997. A nomenclatural study of the *Ganodermataceae* Donk. Fungiflora, Oslo.

Peck CH. 1874. Report of the Botanist. Annual Report of the New York State Museum of Natural History 26: 35-91.

Ryvarden L, Iturriaga T. 2001. Studies in neotropical polypores 9. A checklist of poroid fungi from Venezuela. Mycotaxon 78: 393-405.

Sotão HMP, Hennen JF, Gugliotta AM, Melo OA, Campos EL. 1997. Fungos-Basidiomycotina. 213-219, in: P. Lisboa (org.), Caxiuanã. Belém: MPEG.

MYCOTAXON

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Studies in lichens and lichenicolous fungi: notes on some taxa from eastern North America

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Abstract — *Arthonia lecideella* is placed in synonymy with *Arthonia caesia*. *Lecanora fulva* is placed in synonymy with *Caloplaca flavorubescens*. *Cladonia innominata* is described to accommodate material previously referred to *Cladonia conista*, which is an invalid name. *Lepraria squamatica*, *Staurothele bacilligera* and *S. guestphalica* are reported for the first time from North America.

Key words — Halsey, Schweinitz, Newfoundland, limestone barrens

1. ***Arthonia caesia*** (Flot. ex Körb.) Körb., Parerga Lichenologica, p. 269. 1861.

Syn. nov. *Arthonia lecideella* Nyl. ex Willey, Syn. Gen. Arthonia, p. 16. 1890. TYPE: U.S.A., Massachusetts, Amherst, 1866, on a young red maple in my orchard, *Tuckerman s.n.* (FH-TUCK!, **lectotype designated here**).

The name *Arthonia lecideella* was introduced by Willey (1890) and subsequently widely applied to the taxon now known as *A. caesia*. The type material of *A. lecideella* could not be located in the Willey Herbarium (US) and appears to be lost, thus a lectotype is selected here from the original material in Tuckerman's Herbarium (FH) that was consulted by Willey while he was preparing his synopsis of *Arthonia*. An illustration and description of *A. caesia* has been published by Brodo et al. (2001).

2. ***Caloplaca flavorubescens*** (Huds.) J.R. Laundon, Lichenologist 8(2): 147. 1976.

Syn. nov. *Lecanora fulva* Schwein. ex Halsey, Ann. Lyc. Nat. Hist. New York 1(1): 13. 1824. TYPE: U.S.A., New York, sine loc, *Halsey s.n.* (PH!, **lectotype designated here**).

While examining type specimens of lichens in the Schweinitz Herbarium I discovered that the type material of *Lecanora fulva* is conspecific with the current concept of *Caloplaca flavorubescens*, a corticolous species widespread in eastern North America. Thus *L. fulva* is placed in synonymy with

C. flavorubescens. An illustration and description of *C. flavorubescens* has been published by Brodo et al. (2001).

3. ***Cladonia innominata*** Lendemer, **sp. nov.**

MycoBank MB 511591.

Haec species a Cladonia humile *differt acidum bourgeanicum continente.*

TYPE: U.S.A., Connecticut, Litchfield Co., Canaan, W of Sand Rd., ca. ½ mi N of CT Rte. #126, elev. 600-800 ft., on shaded disturbed soil along an abandoned road along the rim of an old limestone quarry, 21.ix.2003, *Lendemer et al. 1358 = Lich. East. N. Amer. Exs. III: 142* (NY!, **holotype**).

The name *Cladonia conista* (Ach.) Robbins ex A.F. Allen has had a long and confusing nomenclatural history as outlined by Ahti (1980) and Laundon (1984). To summarize the situation, the name *C. conista* has long been applied to the chemotype of *C. humilis* (With.) J.R. Laundon that contains bourgeanic acid. The basionym was regarded to be *Cenomyce fimbriata* var. *conista* Ach. (Ahti 1966); however that name was found to be invalid by Ahti (1980). As a result Ahti (1980) considered *C. fimbriata* f. *conista* Nyl. to be the basionym and selected a specimen from Germany as the type. Laundon (1984), however, pointed out that the name *C. fimbriata* f. *conista* was also invalidly published because it lacked a description. The name *Cladonia conista* is also invalid because when making the combination *C. conista*, Allen (1930) cited only the invalid names of Acharius and Nylander in synonymy. Thus, as has already been discussed by Laundon (1984), this taxon lacks a validly published name.

The taxonomic treatment of this species has not been consistent. Some authors have proposed to recognize it as a distinct taxon at the species level (Ahti 1980, 1993; Evans 1930, Holien & Tønsberg 1985, Thomson 1967) or the varietal level (Laundon 1984), while others have opted not to recognize it at all (Ahti & Hammer 2002). While there is disagreement over the taxonomic status of this entity (*C. conista* auct.), there is also no available (valid) name for it. In the absence of a modern revision of *C. humilis* s. lat., it seems logical to continue to recognize this chemotype as a distinct taxon. It is described here as *C. innominata*. As this species has been included in many regional keys and taxonomic treatments (and when it has not been considered distinct it has still been mentioned in discussions of *C. humilis*), a description is not included here. For reference, the description of *C. conista* published by Holien & Tønsberg (1985) can be consulted. In the field *C. innominata* can be recognized by its short podetia, corticate at the base, and the fine white farinose soredia on the upper portions and the insides of the cups.

4. ***Lepraria squamatica*** Elix, Austral. Lichenol. 58: 20. 2006.

Lepraria squamatica, described from Australia by Elix (2006) and subsequently reported from South America by Flakus & Kukwa (2007) is a chemically distinctive corticolous species that produces squamatic acid as the major secondary metabolite in the thallus. Baeomycesic acid and protocetraric acid also occur as minor accessories with squamatic acid in the thallus of this species. While conducting a survey of the lichens of Cumberland Island, a coastal barrier island in the Gulf of Mexico, Sean Beeching collected a curious *Lepraria*, which he sent to me for identification. The specimen proved to represent *L. squamatica*, which has not previously been reported from North America.

In the field the species could be confused with *L. caesiella* R.C. Harris or *L. friabilis* Lendemer et al. because of the blue-gray color of the thallus and the corticolous habit. *Lepraria caesiella* differs chemically in producing atranorin and zeorin, and at present is not known to occur in the southern Coastal Plain of North America (Lendemer et al. 2008). *Lepraria friabilis*, which does occur in the southern Coastal Plain of North America (Lendemer et al. 2008), differs ecologically in preferring conifers as a substrate, and chemically in producing fumarprotocetraric acid rather than squamatic acid (and the other secondary substances produced in *L. squamatica*). Further collections of this species should be sought in the region; it almost certainly occurs in Florida, USA.

Specimens examined. – **AUSTRALIA. Northern Territory:** Litchfield National Park, 6.viii.2005, *Elix 37755* (NY). **U.S.A. Georgia.** CAMDEN CO.: Cumberland Island, x.2006, *Beeching s.n.* (NY).

5. ***Staurothele bacilligera*** (Arnold) Arnold, Flora 68: 154. 1885.

Staurothele bacilligera is a rare European species occurring on calcareous rocks that is characterized by an endolithic thallus, perithecia immersed in pits, hyaline ascospores (4–8 per ascus), and cylindrical hymenial algae (3–10 × 1–3 µm) (Purvis et al. 1992). While conducting a survey of several limestone barrens of the Great Northern Peninsula of the Island of Newfoundland, Canada, a single collection of this species was made. The limestone barrens of Newfoundland are well known for hosting disjunct populations and endemic taxa of vascular plants. The occurrence of this species in the region is a surprise, but not totally unexpected in light of the results of recent fieldwork in the region (Lendemer, unpublished data).

Selected specimens examined. – **CANADA. Newfoundland and Labrador:** Island of Newfoundland, Northern Peninsula, Burnt Cape Ecological Preserve, N end of Cape, town of Raleigh, Ha-Ha Bay, 14.viii.2007, *Lendemer 11235 & Moroz* (NY!).

6. ***Staurothele guestphalica*** (Lahm ex Körb.) Arnold, Flora 68: 154. 1885.

Much like the preceding species, *Staurothele bacilligera*, *S. guestphalica* is a rare European species of calcareous rocks that is characterized by an endolithic thallus, perithecia immersed in pits, dark brown ascospores (2 per ascus), and globose hymenial algae (2–4.5 µm in diameter) (Purvis et al. 1992). While casually examining coastal limestone outcrops near Western Brook Pond on the west coast of the Island of Newfoundland, Canada, I found what I took in the field to be a species of *Verrucaria* or *Polyblastia* with an endolithic thallus and unusually large perithecia. Since the locality was a brief stop on the way to my intended study area several hours north, I did not examine the material further, although I did collect a voucher. Subsequent examination of the voucher specimen revealed that in fact it represented the first record of *S. guestphalica* for North America. The occurrence of this species on the Island of Newfoundland is not unexpected, yet the discovery of this and the preceding species is particularly interesting. Further fieldwork on the Great Northern Peninsula of the Island of Newfoundland is almost certain to result in the discovery of additional European-North American disjunctions.

SPECIMEN EXAMINED. – **CANADA. Newfoundland and Labrador:** Western Brook Pond, 20.vii.2006, *J.C. Lendemer 8737* (NY).

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Literature cited

Ahti T. 1993. Names in current use in the *Cladoniaceae* (lichen-forming Ascomycetes) in the ranks of genus to variety. *In:* Greuter, W (ed.): NCU-2. Names in Current Use in the Families *Trichocomaceae, Cladoniaceae, Pinaceae,* and *Lemnaceae.* Regnum Vegetabile, Koeltz Scientific Books, Königstein, Germany, pp. 58-106.

Ahti T. 1980. Nomenclatural notes on *Cladonia* species. Lichenologist 12: 125-133.

Ahti T, Hammer S. 2002. *Cladonia.* In Nash III TH, Ryan BD, Gries C, Bungartz F. (eds.): Lichen Flora of the Greater Sonoran Desert Region. I. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 131-158.

Allen AF. 1930. Some *Cladoniae* from the valley of the Cap Chat River and vicinity, Gaspé Peninsula, Quebec. Rhodora 32: 91-94.

Brodo IM, Duran Sharnoff S, Sharnoff S. 2001. Lichens of North America. Yale University Press, New Haven & London. 795 pp.

Elix JA. 2006. A new species of *Lepraria* (lichenized *Ascomycota*) from Australia. Australasian Lichenology 58: 20-23.

Evans AW. 1930. The *Cladoniae* of Connecticut. Trans. Connect. Acad. Arts and Science 30: 357-510.

Flakus A, Kukwa M. 2007. New species and records of *Lepraria* (*Stereocaulaceae,* lichenized *Ascomycota*) from South America. The Lichenologist 39(5): 463-474.

Holien H, Tønsberg T. 1985. Notes on *Cladonia asahinae, C. conista* and the *C. grayi*-group in Norway. Gunneria 51: 1-26.

Lendemer JC, Knudsen K, Elix JA. 2008. *Lepraria friabilis,* a new species from eastern North America. Opuscula Philolichenum 5: 61-66.

Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. (eds.) 1992. The Lichen Flora of Great Britain and Ireland. Natural History Museum Publications & British Lichen Society, London. 710 pp.

Thomson JW. 1967. The Lichen Genus *Cladonia* in North America. University of Toronto Press, Toronto. xi + 172 pp.

Willey H. 1890. A Synopsis of the genus *Arthonia.* New Bedford. 62 pp.

MYCOTAXON

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Two new species of *Exobasidium* (*Exobasidiales*) from China

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Abstract—Two new species, *Exobasidium ovalifoliae* on *Lyonia ovalifolia* var. *elliptica* and *Exobasidium tengchongense* on *Pieris formosa*, are reported. They were collected from Yunnan Province. *Exobasidium ovalifoliae* causes leaf hypertrophy and deformation. It is characterized by 2(–3) sterigmata per basidium and by basidiospores that germinate via germ tubes. *E. tengchongense* causes red leaf spots, and has small basidiospores.

Key words—*Ustilaginomycetes*, symptoms, taxonomy

Two new species of *Exobasidium* were collected from Yunnan Province in 2005. One was found on *Lyonia ovalifolia* var. *elliptica* and the other on *Pieris formosa*. Both host plants belong to the subfamily *Andromedoideae* of *Ericaceae*. To date, 26 species of *Exobasidium* have been recorded in China (Sawada 1922, Teng 1963, Tai 1979, Guo et al. 1991, Zang 1996, Li and Guo 2006a, b, 2008) including the two new species described in this paper.

The first new species is parasitic on young leaves of *Lyonia ovalifolia* var. *elliptica*, causing leaf hypertrophy and deformation. The infected parts of the leaves are concave on the upper surface and convex on the lower surface, subglobose in shape. The diseased parts are at least 7 mm in diam. and sometimes nearly the whole leaf is infected. Usually there are 1–4 deformed parts on each leaf. Transverse sections of a diseased leaf showed no differentiation between the palisade and mesophyll cells. There is hypertrophy and hyperplasia of plant cells. Hyphae protrude between epidermal cells, forming a continuous white hymenium on both surfaces of the leaves at maturity. There are predominantly

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*corresponding author

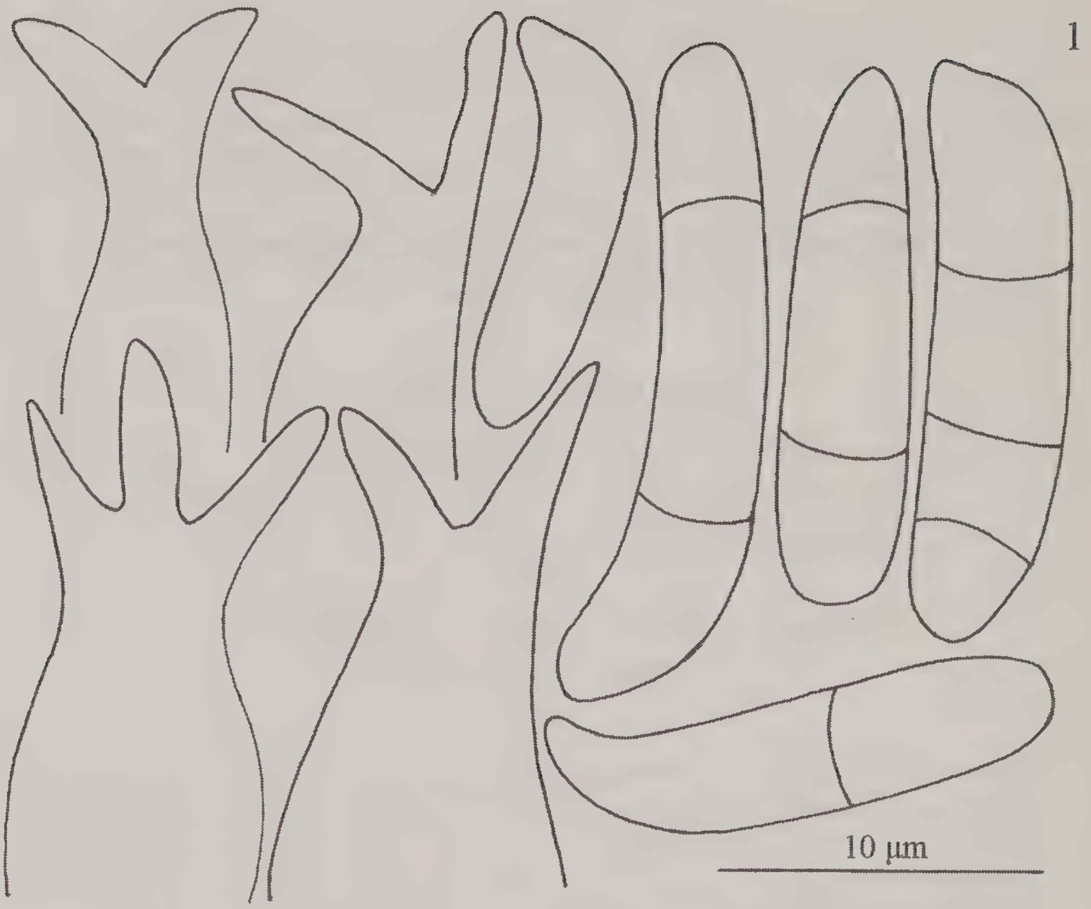

Fig. 1. Line drawings of basidia, sterigmata and basidiospores of *Exobasidium ovalifoliae* on *Lyonia ovalifolia* var. *elliptica* (HMAS 99934, holotype).

2 (rarely 3) sterigmata per basidium. The sterigmata measure 4–8 × 1.3–3 µm and basidiospores 12–20(–23) × 3–4.2 µm. Through scanning electron microscopy basidiospores with long germ tubes were observed. The new species appears to be the same fungus named *Exobasidium pieridis-taiwanense* by Sawada (1959), who failed to provide a Latin diagnosis, thus making his name invalid according to the International Code of Botanical Nomenclature. Sawada described *Exobasidium pieridis-taiwanense* as occurring on *Pieris taiwanensis* Hayata, where it caused swelling of leaves and produced basidia with 2(–3) sterigmata measuring 5–10 × 2.5–3 µm and basidiospores measuring 15–19 × 4.5–6 µm. We were unsuccessful in obtaining the type specimen on loan from TAI (Herbarium of National Taiwan University) and TNS (Mycological Herbarium, National Science Museum, Tokyo, Japan). Among all the validly described taxa on *Ericaceae* plants, *E. pieridis* Henn. (Ezuka 1991) is considered the most closely related species to the present fungus. It attacks the same host and produces similar symptoms. The sterigmata and basidiospores are of similar sizes, but *E. pieridis* has 2–3(–4) sterigmata and produces basidiospores that germinate by producing conidia. We propose the following name for this new species:

Exobasidium ovalifoliae Z.Y. Li & L. Guo, **sp. nov.** **Figs. 1, 3-6**

MycoBank MB 511617

=*Exobasidium pieridis-taiwanense* Sawada, Descriptive Catalogue of Taiwan (Formosan) Fungi XI p. 98, 1959 (nom. inval.).

Hymenium amphigenum. Basidia hyalina, clavata vel cylindrica, 40–70 × 5–8 μm, terminaliter 2(–3) sterigmatibus 4–8 × 1.3–3 μm praedita. Basidiosporae allantoideae vel obvoideae, curvae, 12–20(–23) × 3–4.2 μm, hyalinae, laeves, primo continuae, dein 1-3(–5)-septatae, per hyphas germinantes.

Hymenium amphigenous. Basidia hyaline, clavate or cylindrical, 40–70 × 5–8 μm, with 2(–3) sterigmata. Sterigmata conical, 4–8 × 1.3–3 μm. Basidiospores allantoid or obovoid, 12–20(–23) × 3–4.2 μm, hyaline, smooth, at first continuous, then 1–3(–5)-septate, and slightly curved, germinating by germ tubes.

Specimen examined—On *Lyonia ovalifolia* var. *elliptica* (Siebold & Zucc.) Hand.-Mazz. (*Ericaceae*), Yunnan: Longling, Raolang, alt. 2197 m, 22 IX 2005, Z.Y. Li, L. Guo & N. Liu 229, HMAS 99934 (**holotype**).

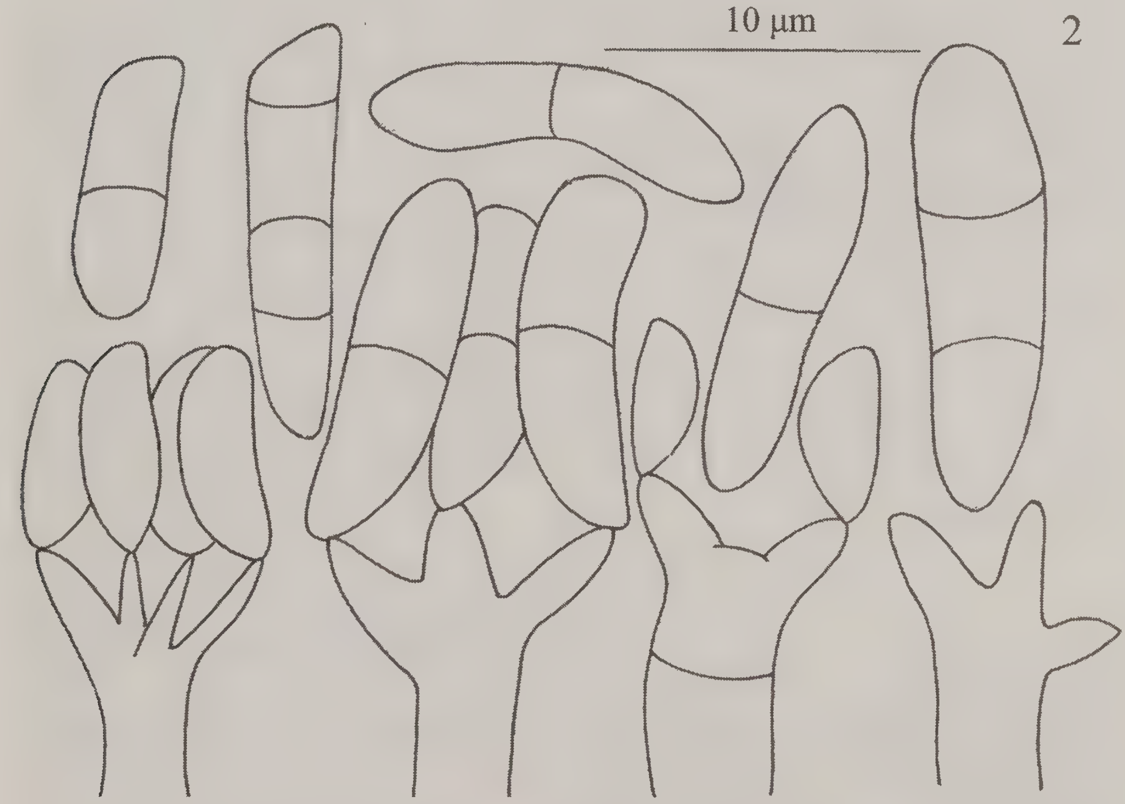

Fig. 2. Line drawings of basidia, sterigmata and basidiospores of *Exobasidium tengchongense* on *Pieris formosa* (HMAS 173149, holotype).

A second new species parasitizes young leaves of *Pieris formosa,* causing leaf spots that are red on the upper surface. The diseased parts are up to 5 mm in diam, with usually one or more diseased parts on each leaf. Transverse sections of the diseased leaf show that there is hypertrophy but no hyperplasia of plant cells. Hyphae protrude between epidermal cells, forming a continuous thick layer on the under surfaces of the leaves at maturity. There are 2–4 sterigmata per basidium. The sterigmata measure 2–4 × 1–2 µm and basidiospores (6.5–) 10–15 × 2.5–4 µm. *Exobasidium asebiae* Hara & Ezuka (Ezuka 1991) on *Pieris japonica* D. Don ex G. Don is similar to this species, but it has large basidiospores measuring 16–23 × 3–5.5 µm.

Exobasidium tengchongense Z.Y. Li & L. Guo, **sp. nov.** **Figs. 2, 7-10**
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Hymenium hypophyllum. Basidia hyalina, cylindrica, 3–5 µm lata, terminaliter 2–4 sterigmatibus 2–4 × 1–2 µm praedita. Basidiosporae cylindricae vel clavatae, (6.5–)10–15 × 2.5–4 µm, hyalinae, laeves, primo continuae, dein 1–3-septatae.

Hymenium hypophyllous. Basidia hyaline, cylindrical, 3–5 µm wide, with 2–4 sterigmata. Sterigmata conical, 2–4 × 1–2 µm. Basidiospores cylindrical or clavate, (6.5–)10–15 × 2.5–4 µm, hyaline, smooth, at first continuous, then 1–3-septate.

Specimen examined—On *Pieris formosa* D. Don (*Ericaceae*), Yunnan: Tengchong, Xiaodifang, alt. 2180 m, 19 IX 2005, Z.Y. Li, L. Guo & N. Liu 201, HMAS 173149 (**holotype**).

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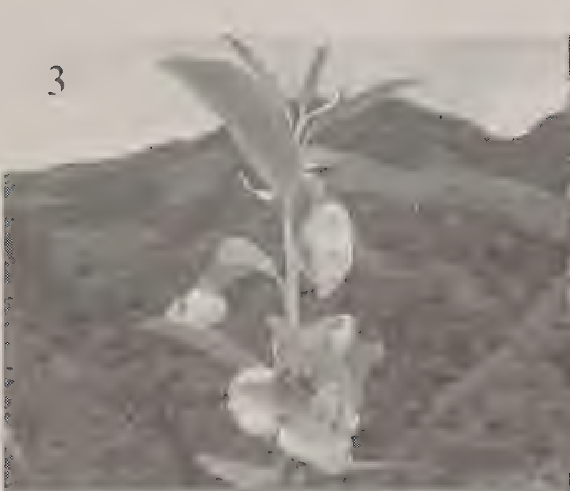
Literature cited

Ezuka A. 1991. Notes on some species of *Exobasidium* in Japan (III). Trans. Mycol. Soc. Japan 32: 71–86.

Guo L, Zhou YL, Li YB. 1991. Study of the genus *Elaeodema* and *Exobasidium sawadae*. Acta Mycol. Sin. 10: 31–35.

Figs. 3-6. *Exobasidium ovalifoliae* on *Lyonia ovalifolia* var. *elliptica* (HMAS 99934, holotype). Fig. 3. Symptoms. Fig. 4. Basidiospores and germ tubes as seen by SEM. Fig. 5. Basidium, sterigmata and basidiospore as seen by LM. Fig. 6. Basidium, sterigmata and basidiospores as seen by SEM. **Figs. 7-10.** *Exobasidium tengchongense* on *Pieris formosa* (HMAS 173149, holotype). Fig. 7. Symptoms. Figs. 8-9. Basidia, sterigmata and basidiospores as seen by LM. Fig. 10. Basidium and sterigmata as seen by SEM.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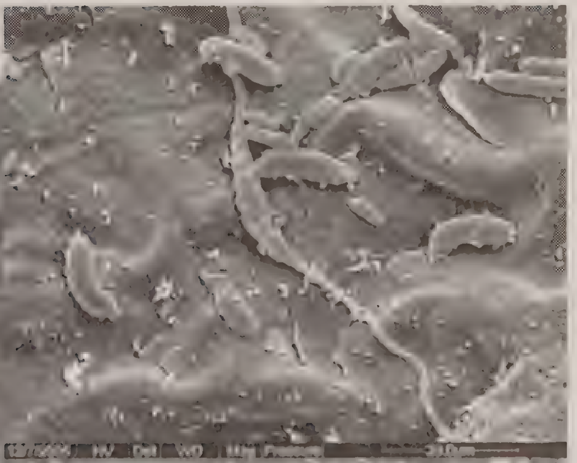
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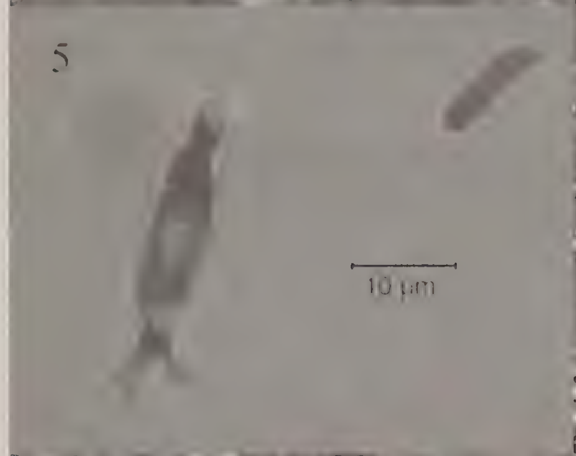
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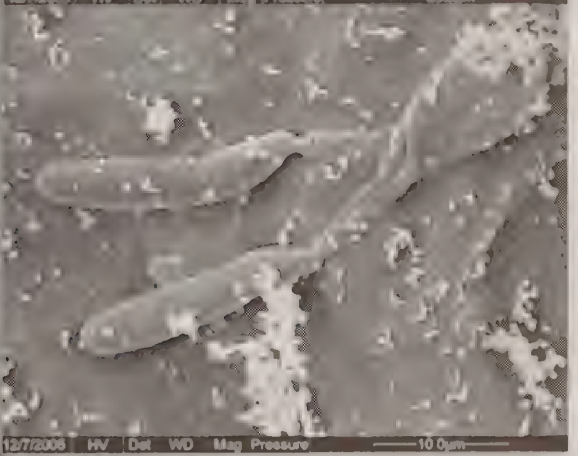
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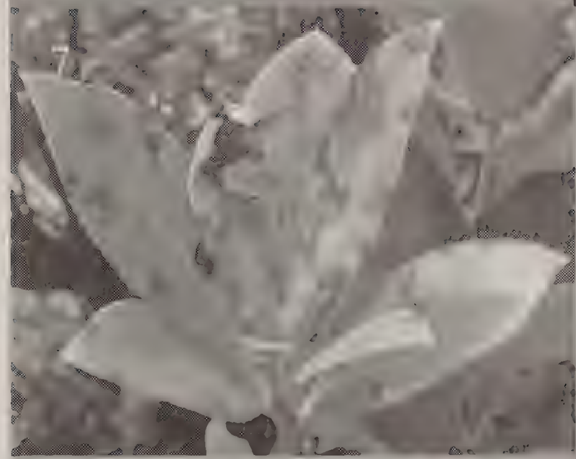

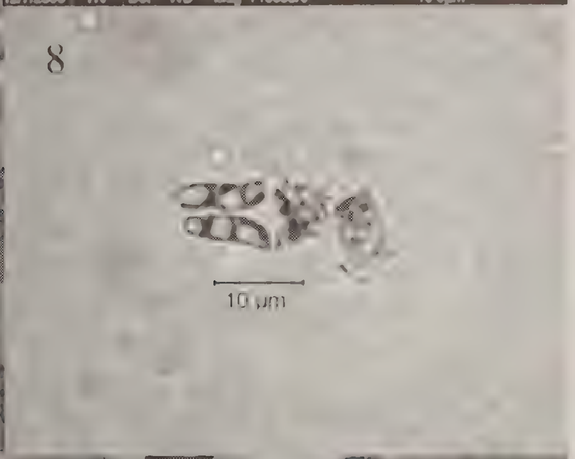
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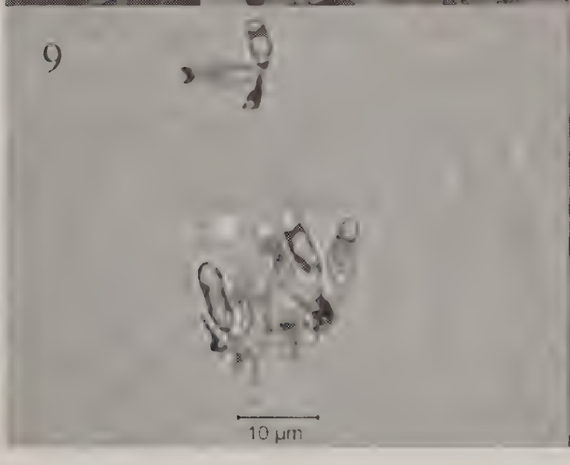
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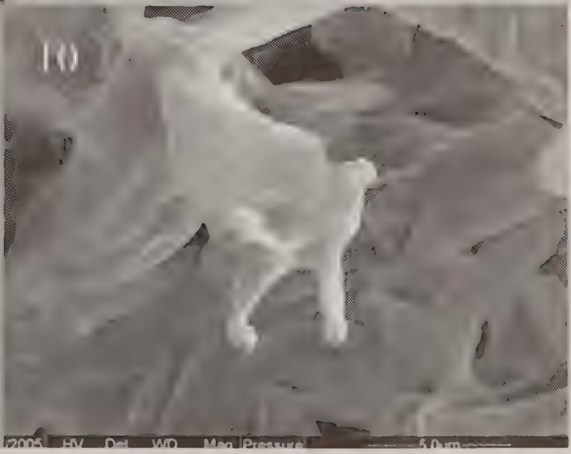
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Li ZY, Guo L. 2006a. A new species of *Exobasidium* (*Exobasidiales*) on *Rhododendron* from China. Mycotaxon 96: 323–326.

Li ZY, Guo L. 2006b. A new species and a new Chinese record of *Exobasidium* (*Exobasidiales*) from China. Mycotaxon 97: 379–384.

Li ZY, Guo L. 2008. Three new species and a new Chinese record of *Exobasidium* (*Exobasidiales*) in China. Fung. Divers. (in the press).

Sawada K. 1922. Descriptive catalogue of the Formosan fungi. Part II. Dept. Agr. Gov't. Res. Inst. Formosa. Report 2. *Exobasidiales*. 106–110.

Sawada K. 1959. Descriptive catalogue of Taiwan (Formosan) fungi XI. In: Imazeki, R., Hiratsuka, N., Asuyama, H. (eds.) Special Publication no. 8, College of Agriculture, National Taiwan University. 1–268.

Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing. 1–1527.

Teng SC. 1963. Fungi of China. Science Press, Beijing. 1–808.

Zang M. 1996. Fungi of the Hengduan Mountains. Science Press, Beijing. 1–598.

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Taxonomy of the species in the *Phellinus igniarius* group

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Abstract — Differences between the species of the *Phellinus igniarius* complex are characterized using morphological and molecular analysis. The study focuses on the possibly new taxa collected from ashes (*Fraxinus*), maples (*Acer*) and oaks (*Quercus*). It is shown that the species growing on ashes and maples belong to *Phellinus alni*. The situation regarding *Phellinus* found on oaks is unclear: that material belongs to *Phellinus alni* genetically but differs somewhat in its micromorphology.

Key words — wood-rotting polypores, *Hymenochaetaceae*, morphology, rDNA ITS

Introduction

Twelve species of *Phellinus igniarius* group are known in Europe, nine of which occur in Estonia (*Phellinus alni* (Bondartsev) Parmasto, *P. cinereus* (Niemelä) M. Fisch., *P. igniarius* (L.: Fr.) Quél., *P. laevigatus* (P. Karst.) Bourdot & Galzin, *P. lundellii* Niemelä, *P. nigricans* (Fr.: Fr.) P. Karst., *P. populicola* Niemelä, *P. tremulae* (Bondartsev) Bondartsev & P.N. Borisov, *P. tuberculosus* (Baumg.) Niemelä).

The *P. igniarius* group, one of the most important wood-rotting fungi of many deciduous trees, was described by Fries (1821) with two species: *Polyporus igniarius* (synonyms: *Boletus igniarius*, *Fomes igniarius*, *Phellinus igniarius*) growing on *Salix* and *Fraxinus* trees, and *Polyporus nigricans* (*Fomes nigricans*, *Boletus nigricans*) growing on *Betula*. Several forms of *Phellinus igniarius* (as *Fomes igniarius*) were distinguished by Bondartsev (1912); today these are recognized as independent species: forma *alni* is *Phellinus alni*, f. *betulae* is probably *Phellinus cinereus*, f. *tremulae* is *Phellinus tremulae*, f. *pruni* is *Phellinus tuberculosus* and f. *quercus* is *Fomitiporia robusta* (Larsson et al. 2007). For delimiting species in the *P. igniarius* group, morphological, as well as molecular characters have been used (Niemelä 1972, 1974, 1975, 1977, 2005, Parmasto 1976, 2007, Fischer 1987, 1995, Wagner & Fischer 2001, Sell 2006).

However, morphological differences are small and not dependable for species delimitation.

Most species of this group are highly host-specific, and it is possible that some more, new species may be found on different hosts. The aim of the present study is to give an overview about the taxonomy of the species in the *P. igniarius* group. Particularly, the paper attempts to clarify whether the collections from ashes (*Fraxinus*), maples (*Acer*) and oaks (*Quercus*) belong to known species or represent undescribed new taxa.

Materials and methods

The study is based on specimens and strains preserved at the mycological herbarium (TAA) and culture collection (TFC) of the Institute of Agricultural and Environmental Sciences of the Estonian University of Life Sciences, Tartu, Estonia. Also one strain from the CBS fungal collections and 29 sequences from the European Molecular Biology Laboratory (EMBL) genebank were used (Table 1). In addition to the nine species mentioned above, specimens of *Phellinus igniarius* s.l. collected from ash, maple and oak, were also studied: they are tentatively named as 'P. fraxini', 'P. aceris' and 'P. quercus'.

Ten to twelve basidiocarps from each known and putative species were studied morphologically. Most of these were collected in Estonia. Thirty spores and 15 setae from each specimen were measured in 3% aqueous KOH using a Nikon Labophot-2 microscope. Parallel versus interwoven hyphal arrangement in the dissepiments was estimated for each specimen. The number of pores per millimetre was counted on each basidiocarp from ten different places with the help of a dissecting microscope, and the average was calculated. In the basidiocarps several morphological characters were studied: character of the upper surface (presence of crevices, colour, width of the zones and marginal zone), shape of the margin (acute, narrowly- or widely-roundish), thickness measured in the middle of the length (radius from the base to the edge), thickness of the context and the presence of the core. For phenetic analyses different distance measuring methods (Manhattan, Eucleides) and clustering methods (Complete, UPGMA) in the program NTSYSpc vers. 2 were used.

rDNA was isolated from cultures using High Pure PCR Template Preparation Kit. PCR reactions were made using puReTaqTM Ready-To-GoIM PCR Beads (Amersham Biosciences, Uppsala). PCR products were purified using ExoSAP solution and sequenced at the MWG-Biotech AG (Ebersberg, Germany). The primers used to amplify the ITS region were ITS1F and ITS4 (White et al. 1990). The sequences were edited and assembled using the Sequencher 4.7 (Gene Codes, Ann Arbour) and aligned automatically with the program MAFFT, followed by adjustment with the program GENEDOC 2.6.0.3. All DNA-sequences of strains from the collection TFC studied were sent to EMBL GenBank. Phylogenetic analyses were made using the program PAUP 4.0b10 (Swofford 2002). Bootstrapping was performed using 10 000 replicates. This was followed by additional swapping of the trees. Applying maximum parsimony algorithm, *Fomitiporia robusta*, *Fomitiporia punctata* and *Phellinus bicuspidatus* were used as an outgroup. Krall et al. (2007) botanical nomenclature was used as the source of the host names when characterizing the specialization of *P. igniarius* s.l. species.

Table 1. Specimens of *Phellinus* used in the analysis of molecular data with their voucher numbers in TFC collection and GenBank

Sample	Species	TFC number	GenBank number
'P. fraxini' 1	*Phellinus alni (Fraxinus)*	2005-16	AM 931245
'P. quercus' 1	*Phellinus alni (Quercus)*	2006-01	AM 931250
'P. fraxini' 2	*Phellinus alni (Fraxinus)*	2000-05	AM 931242
'P. aceris' 1	*Phellinus alni (Acer)*	2005-40	AM 931243
'P. aceris' 2	*Phellinus alni (Acer)*	2005-123	AM 931244
'P. fraxini' 3	*Phellinus alni (Fraxinus)*	2005-33	AM 931246
'P. aceris' 3	*Phellinus alni (Acer)*	2005-38	AM 931249
'P. quercus' 2	*Phellinus alni (Quercus)*	2006-02	AM 931251
P. alni 1	*Phellinus alni*		AY 340035
P. alni 2	*Phellinus alni*		AY 340036
P. alni 3	*Phellinus alni*		AY 340040
P. alni 4	*Phellinus alni*		AY 340041
P. alni 5	*Phellinus alni*		AY 340042
P. alni 6	*Phellinus alni*		AY 340037
P. alni 7	*Phellinus alni*		AY 340038
P. igniarius s.str. 1	*Phellinus igniarius* s.str.	2005-34	AM 931247
P. igniarius s.str. 2	*Phellinus igniarius* s.str.		AF 515574
P. igniarius s.str. 3	*Phellinus igniarius* s.str.		AY 340069
P. populicola 1	*Phellinus populicola*	81-48	AM 931252
P. populicola 2	*Phellinus populicola*		AY 558638
P. cinereus 1	*Phellinus cinereus*	2005-37	AM 931248
P. cinereus 2	*Phellinus cinereus*		AY 340043
P. cinereus 3	*Phellinus cinereus*		AY 340047
P. nigricans 1	*Phellinus nigricans*		AF 200239
P. nigricans 2	*Phellinus nigricans*		AY 558631
P. lundellii 1	*Phellinus lundellii*		AY 340058
P. lundellii 2	*Phellinus lundellii*		AY 340060
P. tremulae 1	*Phellinus tremulae*		AY 340064
P. tremulae 2	*Phellinus tremulae*		AY 340066
P. tuberculosus 1	*Phellinus tuberculosus*		AY 529699
P. tuberculosus 2	*Phellinus tuberculosus*		AY 529700
P. laevigatus 1	*Phellinus laevigatus*		AY 340054
P. laevigatus 2	*Phellinus laevigatus*		AY 340055
P. betulinus 1	*Phellinus betulinus* ssp. *orienticus*		AY 558626
P. laevigatus 3	*Phellinus laevigatus*		AY 340056
P. bicuspidatus 1	*Phellinus bicuspidatus*		AY 189699
P. bicuspidatus 2	*Phellinus bicuspidatus*		AY 558610
F. robusta 1	*Fomitiporia robusta*		AY 340007
F. robusta 2	*Fomitiporia robusta*		AY 340018
F. punctata 1	*Fomitiporia punctata*		AY 558640

Results

Morphological characters

On the basis of spore size three species and three groups can be recognized in the *P. igniarius* complex. Spores of *P. nigricans* and *P. cinereus* are characterized by the largest spores (mean length 6.55 and 6.46 µm, mean width 5.86 and 5.77 µm, respectively) in the group (Fig. 1). Likewise, 'P. quercus' can be distinguished from all other species according to this character (mean length 6.22 × width 5.46 µm). *P. alni* (5.94 × 5.11 µm), *P. igniarius* s.str. (5.85 × 5.07 µm), 'P. aceris' (5.81 × 5.04 µm) and 'P. fraxini' (5.81 × 5.02 µm) formed one group; *P. populicola* (5.58 × 4.76 µm), *P. tuberculosus* (5.55 × 4.52 µm) and *P. lundellii* (5.54 × 4.57 µm) another, both of which are characterized by overlapping spore sizes of the constituting species. The species having the smallest spores in the group, *P. tremulae* (4.99 × 4.08 µm) and *P. laevigatus* (4.58 × 3.75 µm) can both be distinguished according to their spore size.

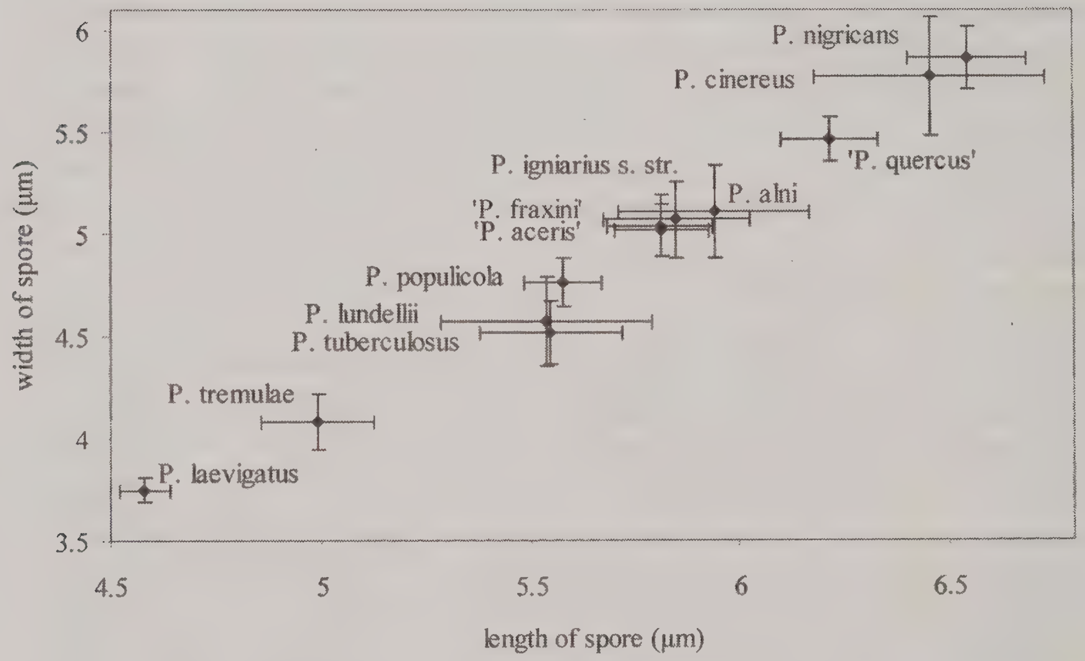

Fig. 1. Mean spore length, width and standard deviation among the species in the *Phellinus igniarius* group.

Setal size offers clear distinction of *P. tremulae* and *P. tuberculosus* by having larger setae than other species (mean length 18.22 and 16.97 µm, mean width 7.35 and 6.74 µm, respectively) (Fig. 2). In all other species the mean values of this feature were found to overlap. Hyphal arrangement in the dissepiments enables the species to divide into two groups. Three species, *P. tuberculosus*, *P. tremulae* and *P. laevigatus* have parallel arrangement of hyphae in the dissepiments, while in the other species the hyphae are interwoven.

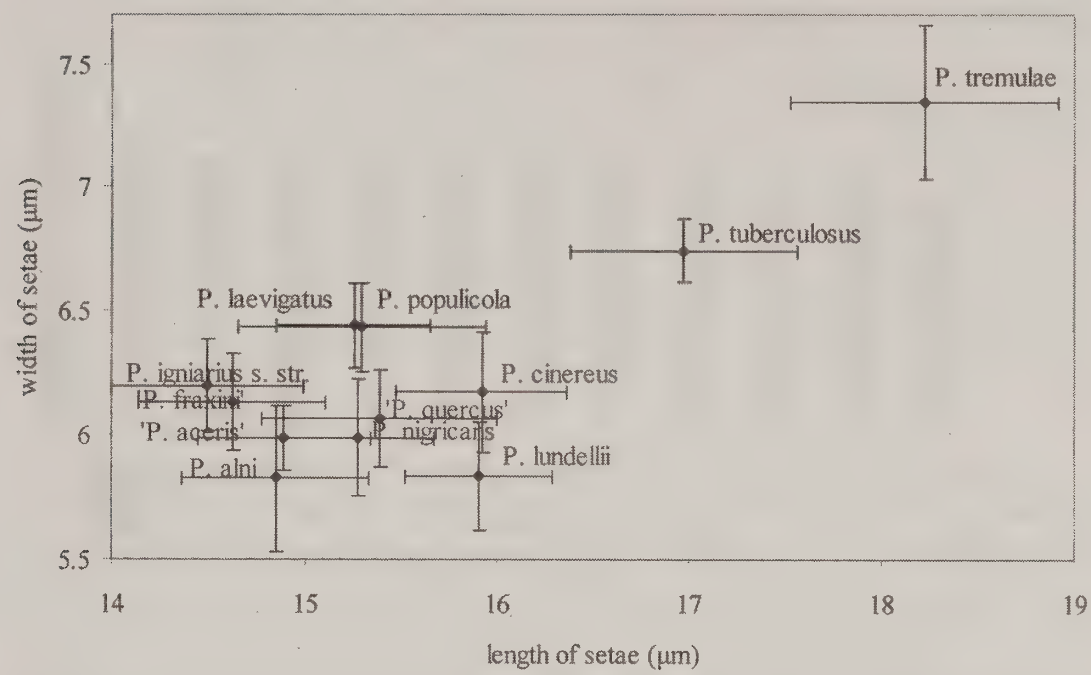

Fig. 2. Mean setal length, width and standard deviation among the species in the *Phellinus igniarius* complex.

Basidiocarps of *P. laevigatus* have more pores per millimetre (7.2 in average) than the other species (4.2–5.1) (Fig. 3). The number of pores per millimetre offers a good opportunity for distinguishing *P. laevigatus* from the other species.

Relative importance of rimose upper surface of the basidiocarps was highest in *P. nigricans*. Rimose upper surface characterizes also the basidiocarps of ‘P. aceris’, ‘P. fraxini’ and *P. populicola*. Crevices on the upper surface of the basidiocarps of *P. lundellii* and *P. tuberculosus* are usually absent.

Percentage of the basidiocarps with widely zoned (zones 0.7 cm or more on average) upper surface is highest in *P. populicola* and ‘P. fraxini’, half of the basidiocarps of ‘P. quercus’ and ‘P. aceris’ are also wide-zoned. In the other species, most of the basidiocarps are narrowly zoned (average width less than 0.7 cm). Basidiocarps of *P. nigricans* are mostly narrowly zoned, and all of *P. tremulae* are narrow-zoned.

Higher percentage of basidiocarps with mostly wide (0.7 cm or more) marginal zone was observed in ‘P. aceris’, ‘P. quercus’ and ‘P. fraxini’, but also in *P. tuberculosus* and *P. alni*. Most of the basidiocarps of *P. populicola* and *P. lundellii* have narrow (less than 0.7 cm) marginal zone. All basidiocarps of *P. nigricans* have a narrow marginal zone.

All basidiocarps of *P. nigricans* studied are characterized by black or dark grey upper surface. Few of the basidiocarps of *P. cinereus* and *P. tuberculosus*

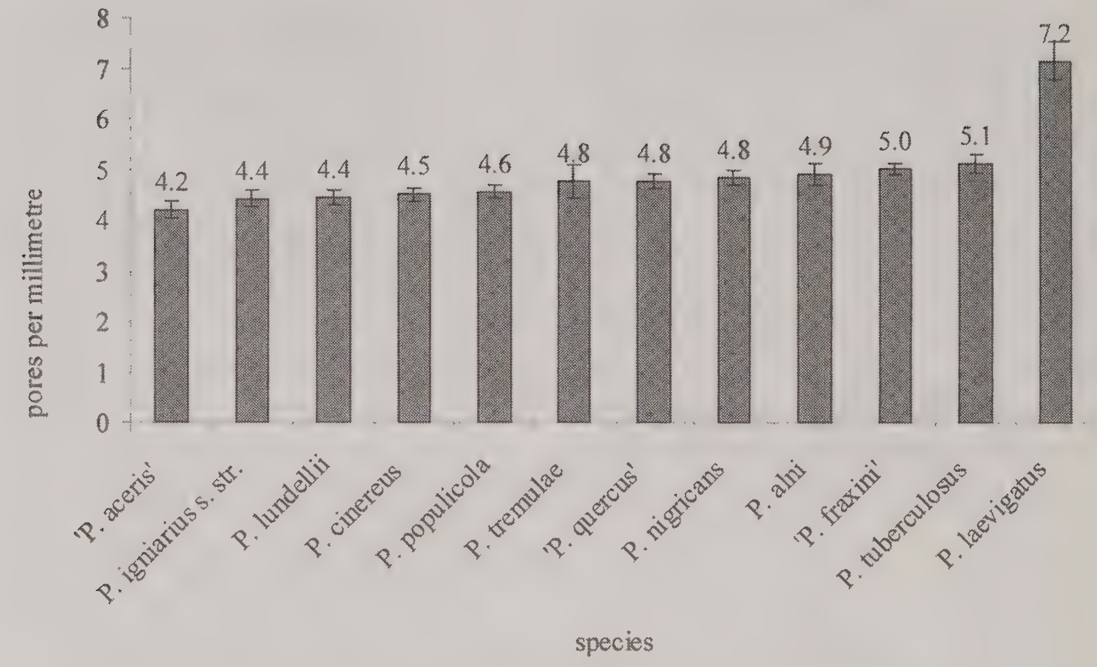

Fig. 3. Average number of pores per millimetre with standard deviation among the species in the *Phellinus igniarius* group.

are black or dark grey. The percentage of basidiocarps with grey upper surface is higher in *P. tuberculosus*. The percentage of basidiocarps with brownish grey upper surface is higher in *P. cinereus*, and also in 'P. quercus', 'P. fraxini' and 'P. aceris'. Half of the basidiocarps of *P. lundellii* have brown upper surface, this colour being present also in the basidiocarps of *P. cinereus* and 'P. quercus', and seldom in 'P. aceris', *P. tuberculosus*, *P. populicola* and *P. igniarius* s.str.

Most of the basidiocarps of *P. nigricans*, *P. lundellii* and *P. tremulae* have acute margins, some have roundish margins, and there are no basidiocarps with widely-rounded margins in these species. In the rest of the species, there are basidiocarps with acute as well as roundish or widely-roundish margins. The percentage of basidiocarps with roundish margins is higher in *P. populicola* and *P. alni*. Widely roundish margins are usual in basidiocarps of *P. alni* and 'P. aceris'.

'P. aceris' has the thickest context compared with the thickness of the basidiocarp; also *P. alni* and 'P. fraxini' have also comparatively thick context. *P. nigricans* and *P. tremulae* have thin context with a relative thickness of one-half or less compared to the other species.

All basidiocarps of *P. alni* and 'P. aceris' and most basidiocarps of *P. populicola*, 'P. quercus' and 'P. fraxini' have a core in the base of the basidiome. The core is rare in *P. cinereus* and *P. igniarius* s.str. and absent in all basidiocarps of *P. nigricans*, *P. tuberculosus*, *P. lundellii*, *P. populicola* and *P. laevigatus*.

In the phenetic analysis of all morphological characters using the program NTSYSpc, Manhattan distance measuring and complete clustering, no one-species clusters were observed except that of *P. laevigatus*. Four specimens of *P. quercus* form a cluster distinct from all other specimens studied, but four other specimens of the same taxon are scattered in the dendrogram in the clusters together with *P. alni* and *P. cinereus*. In the *P. nigricans* cluster some *P. igniarius* s.str. specimens are included, and in the *P. tremulae* cluster several *P. tuberculosus* specimens. 'P. aceris' and 'P. fraxini' are intermixed with several other species in many clusters of the dendrogram. The other measuring and clustering methods (Eucleides, UPGMA) did not give more clear results.

Molecular characters

Ingroup constituted DNA-sequences of 35 strains of the *P. igniarius* s.l. specimens. Ribosomal DNA ITS region data matrix contained 733 characters of which 248 were parsimony-informative. Phylogenetic analysis resulted in 4 083 800 most parsimonious trees of 447 steps. In the strict consensus tree, nine monophyletic groups distinguished, 10 of which represent *P. igniarius* group species (Fig. 4). All the species of the *P. igniarius* complex form one clade, which has a very strong support (100 % in bootstrap analysis).

The *P. alni* clade is part of a larger well supported clade (92 %) that also includes the clades of *P. igniarius* s.str.–*P. populicola*, *P. cinereus*–*P. nigricans*, and *P. lundellii*. All the *P. igniarius* s.l. specimens studied molecularly growing on *Acer*, *Fraxinus* and *Quercus* form one clade with seven *P. alni* (on *Alnus* or *Betula*) strains obtained from EMBL genebank. However, this moderately supported clade (79 % in bootstrap analysis) remains mostly unresolved. The only subclade, comprising a specimen growing on *Fraxinus* and another on *Quercus*, is weakly supported in bootstrap analysis (62 %).

The clade uniting *P. igniarius* s.str. and *P. populicola* is strongly supported (99 %). While support for *P. igniarius* s.str. subclade is weak (63 %), the subclade of *P. populicola* received strong support (100 %). *P. nigricans* and *P. cinereus* together form a well supported (92 %) clade, while strains of *P. nigricans* form moderately and strains of *P. cinereus* weakly supported subclade (86 % and 71 % respectively). The clade of *P. lundellii* has also strong support (100 %). The other species of the *P. igniarius* complex form clades which correspond to the species *P. tremulae*, *P. tuberculosus*, and *P. laevigatus*.

Discussion

The results of the present study show that spore measurements of *P. igniarius* s.l. growing on *Quercus*, *P. tremulae* and *P. laevigatus* differ from the other species in the *P. igniarius* complex. The rest of the species form three groups. Spore size seems to be a good character for distinguishing separate species, but even if

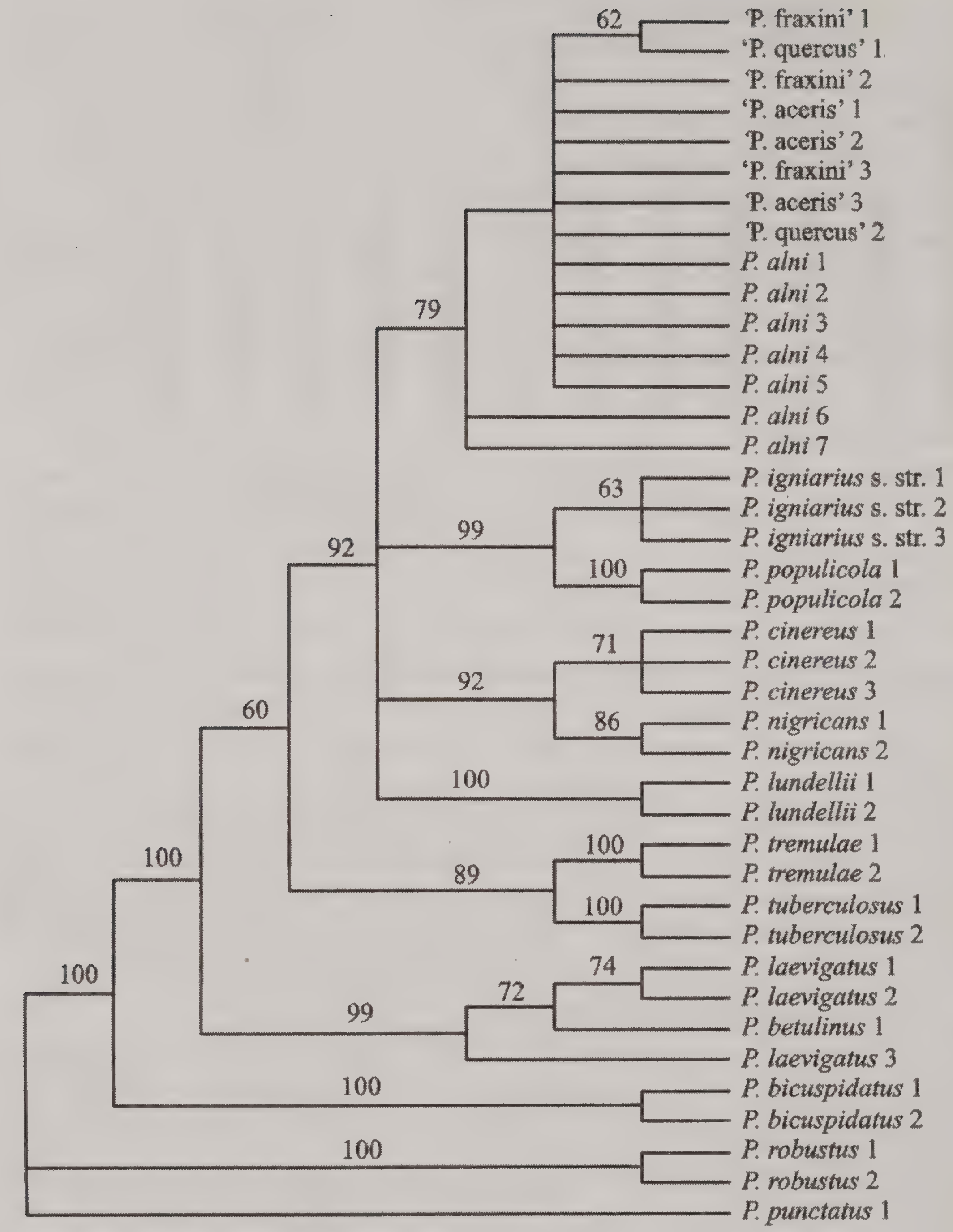
62
'P. fraxini' 1
'P. quercus' 1
'P. fraxini' 2
'P. aceris' 1
'P. aceris' 2
'P. fraxini' 3
'P. aceris' 3
'P. quercus' 2
P. alni 1
P. alni 2
P. alni 3
P. alni 4
P. alni 5
79
P. alni 6
P. alni 7
63
P. igniarius s. str. 1
P. igniarius s. str. 2
99
P. igniarius s. str. 3
92
100
P. populicola 1
P. populicola 2
71
P. cinereus 1
92
P. cinereus 2
60
P. cinereus 3
86
P. nigricans 1
P. nigricans 2
100
P. lundellii 1
P. lundellii 2
100
100
P. tremulae 1
89
P. tremulae 2
100
P. tuberculosus 1
P. tuberculosus 2
74
100
P. laevigatus 1
72
P. laevigatus 2
99
P. betulinus 1
P. laevigatus 3
100
P. bicuspidatus 1
P. bicuspidatus 2
100
P. robustus 1
P. robustus 2
P. punctatus 1

Fig. 4. Strict consensus tree of *Phellinus* species, calculated from 4 083 800 most parsimonious trees, found in the maximum parsimony analysis. Tree length 447 steps, consistency index 0.81. Numbers on the branches show the bootstrap support. Data of the specimens studied are indicated in Table 1.

the differences are statistically significant, they do not enable us to identify the specimens in all cases as proposed by Sell (2006). Setae are useful at specific level throughout the family of *Hymenochaetaceae* (Niemelä 1972). Measurements of hymenial setae distinguished both *P. tremulae* and *P. tuberculosus* from the rest of the species in which size of setae was found to be largely overlapping. According to the density of pores per millimetre on the hymenophore, *P. laevigatus* differs from all the other species in the *P. igniarius* group exhibiting largest number of pores per millimetre. While the core is found in most of the examined specimens of *P. alni*, it is absent in all studied basidiocarps of *P. nigricans*, *P. tuberculosus*, *P. lundellii*, *P. tremulae* and *P. laevigatus*.

Both morphological and molecular characters are important for species delimitation (Lee 2004). Although studies of morphological characters need less time and are simpler, these characters are variable. *P. nigricans* usually differs from the other species in its basidiocarp characters: upper surface is rimose, black or dark-grey coloured with narrow marginal and other zones. On the other hand, it is difficult or almost impossible to distinguish *P. cinereus* and *P. nigricans* using morphological characters. Molecular data offers clear separation as demonstrated also by Wagner & Fischer (2001).

Most of the phenetic clustering methods applied to the studied morphological characters did not separate the putative species, except the taxa growing on *Quercus* spp. Phenetic clustering methods (Manhattan, Eucleides) are almost useless in the study of morphological characters, and only statistical spore measurement data gave some useful information for distinguishing species.

The analysis of molecular characters indicated that the specimens of *P. igniarius* s.l. growing on *Acer*, *Fraxinus* and *Quercus* neither belong to *P. cinereus* nor represent new species as supposed in some previous studies (Parmasto 1993, 2004). The results of the present study with the use of molecular characters showed that the specimens growing on *Acer*, *Fraxinus* and *Quercus* are very closely related to *P. alni* (growing on *Alnus* spp.). However, the clade received only moderate support (79 %) to be unambiguously considered as containing just one species.

Taxonomic status of the specimens found on *Quercus* is unclear. According to the molecular data, these belong to *P. alni*, but morphological data (spore size and basidiocarp characters) are remarkably different. In the present research ITS rDNA region was studied, the region most widely used as a species-level molecular marker in fungi. Fischer & Binder (1995) used the mating tests for studying *Phellinus* species on *Betula*. Using the mating tests may be laborious; however, it may help to clear up the taxonomic position of the specimens growing on *Quercus*. Isoenzymatic analyses can also be of help to solve some taxonomical problems in the above-mentioned complex.

In general, the species in the *P. igniarius* group are narrowly specialized according to hosts: *P. nigricans*, *P. cinereus*, *P. lundellii* and *P. laevigatus* are mostly species of *Betula*; *P. igniarius* s.str. grows on the members of the genus *Salix*; *P. populicola* and *P. tremulae* on *Populus*; *P. tuberculosus* on drupes (*Prunus insititia, Prunus domestica, Cerasus vulgaris*). *P. alni* differs from the others by its wide host range: it grows on *Alnus*, *Betula*, *Corylus*, *Malus*, *Padus avium*, *Sorbus*, and as a result of the present study, also on *Acer* and *Fraxinus*. Probably, *P. igniarius* s.l. growing on *Fagus* and *Carpinus* in Central and East Europe also belongs to *P. alni*.

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Literature cited

Bondartsev AS. 1912. Griby sobrannye na stvolakh lesnykh porod v Bryanskom opytnom lesnichestve. Trudy Lesn. Opytn. Delu Rossii 37: 1–56

Fischer M. 1987. Biosystematische Untersuchungen an den Porlingsgattungen *Phellinus* Quél. und *Inonotus* Karst. Biblioth. Mycol. 107: 1–33

Fischer M. 1995. *Phellinus igniarius* and its closest relatives in Europe. Mycol. Res. 99: 735–744

Fischer M, Binder M. 1995. *Phellinus* species on *Betula*. Mating tests, RFLP analyses of enzymatically amplified rDNA, and relations to *Phellinus alni*. Karstenia 35: 67–84

Fries EM. 1821. Systema mycologicum. E. Mayritius, Gryphiswaldiae. 520 p.

Krall H, Kukk T, Kull T, Kuusk V, Leht M, Oja T, Reier Ü, Sepp S, Zingel H, Tuulik T. 2007. Identification guide of Estonian Plants. Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Tartu. 447 p. (in Estonian).

Larsson KH, Parmasto E, Fischer M, Langer E, Nakasone K, Redhead S. 2007. *Hymenochaetales*: a molecular phylogeny for the hymenochaetoid clade. Mycologia 98: 926–936

Lee M. 2004. Molecular and morphological datasets have similar numbers of relevant phylogenetic characters. Taxon 53: 1019–1022

Niemelä T. 1972. On Fennoscandian polypores. II. *Phellinus laevigatus* (Fr.) Bourd. & Galz. and *P. lundellii* Niemelä, n. sp. Ann. Bot. Fennici 9: 41–59

Niemelä T. 1974. On Fennoscandian polypores. III. *Phellinus tremulae* (Bond.) Bond. & Borisov. Ann. Bot. Fennici 11: 202–215

Niemelä T. 1975. On Fennoscandian polypores. IV. *Phellinus igniarius*, *P. nigricans* and *P. populicola*, n. sp. Ann. Bot. Fennici 12: 93–122

Niemelä T. 1977. On Fennoscandian polypores 5. *Phellinus pomaceus*. Karstenia 17: 77–86

Niemelä T. 2005. Polypores, lignicolous fungi. Norrlinia 13: 1–320 (in Finnish, with English summary).

Parmasto E. 1976. Studies of Yakutian fungi. II. Proc. Estonian Acad. Sci. Biol. 25: 316–321

Parmasto E. 1993. Distribution maps of Estonian fungi. I. *Hymenochaetaceae*. Institute of Zoology and Botany of the Estonian Academy of Sciences, Tartu.

Parmasto E. 2004. Distribution maps of Estonian fungi. III. Pore fungi. Institute of Zoology and Botany of the Estonian Agricultural University, Tartu.

Parmasto E. 2007. *Phellinus laevigatus* s.l. (*Hymenochaetales*): a ring species. Folia Cryptog. Estonica 43: 39–49

Sell I. 2006. Size and shape of basidiospores in the *Phellinus igniarius* group. Agronomy Research 4: 359–362

Swofford DL. 2002. PAUP*. Phylogenetic analyses using parsimony (* and other methods), 4b10. Sinauer Associates, Sunderland.

Wagner T, Fischer M. 2001. Natural groups and a revised system for the European poroid *Hymenochaetales* (*Basidiomycota*) supported by nLSU rDNA sequence data. Mycol. Res. 105: 773–782

White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds), PCR protocols: A guide to Methods and Applications, Academic Press, San Diego, pp. 315–322.

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A new *Armillaria mellea* variant from tops of coastal sand dunes in southern Spain

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Abstract — An atypical ecological variant of *Armillaria mellea*, growing on coastal sand dunes in southern Spain associated with *Retama monosperma*, is described and illustrated based on morphological, ecological and molecular evidence. Both macro- and micro-morphological features, combined with ecological data, support the segregation of these populations from typical *A. mellea* collections. Sequencing of the D1-D2 domains of the 28S rRNA gene and the ITS region suggests their strong affinities with *A. mellea*. Although the molecular data do not support their segregation as a different taxon, they illustrate the wide morphological and ecological variability within this species. Phylogenetic trees provide additional insights on the geographical diversity within the *A. mellea* complex, showing four distinct groups with different geographic origins: Asia, East North America, West North America, and Europe.

Key Words — *Marasmiaceae*, taxonomy, morphological variability

Introduction

The genus *Armillaria* has been studied from several perspectives: morphology (e.g. Kühner & Romagnesi 1953, Singer 1956, Kile & Watling 1983, Marxmüller 1992), nomenclature (e.g. Watling et al 1982, Termorshuizen & Arnolds 1987, Volk & Burdsall 1995), sexual compatibility (e.g. Korhonen 1978), molecular phylogeny (e.g. Mwenje et al 2003, 2006, Kim et al 2006), and geographical diversity (Coetzee et al 2000, 2001). Several *Armillaria* species have been collected in southern areas of the Iberian Peninsula, such as *A. cepistipes* Velen., *A. gallica* Marxm. & Romagn., *A. mellea* (Vahl.: Fr.) P. Kumm., *A. ostoyae* (Romagn.) Herink and *A. tabescens* (Scop.) Emel. They can be found in sclerophyllous (*Quercus ilex* L., *Q. suber* L.) and deciduous forests (e.g. on riverside communities), in coniferous forests (e.g. *Abies pinsapo* Boiss., *Pinus* spp., etc.), as well as in gardens, parks and cultivated land, under ornamental or fruit trees. These fungi grow typically on low drainage soils that are flooded frequently, but they are rarely found growing in sandy soils. *Armillaria* species are saprobic fungi, but they can also act as opportunistic, virulent plant parasites, responsible for the *Armillaria* root rot, which causes extensive economical losses (Cox et al 2006).

In November 2005, one of the authors (A.O.) observed on shoreline dunes in the province of Cádiz (southern Spain) an agaricoid fungus (coll. 1) growing in dense clusters composed of sometimes more than 100 basidiomata on bare sandy soil close to *Retama monosperma* (L.) Boiss. and *Ammophila arenaria* (L.) Link. In the same location on the back of one dune, also at the base of *R. monosperma*, we collected another agaricoid fungus (coll. 2) also growing in clusters (eight basidiomata) and with several different macroscopic features. Microscopic study, however, showed them to be very similar.

Analysis of the morphological characters suggested that we were observing a psammophilous variant of *A. mellea*, with macromorphological differences most probably caused by environmental conditions. Our preliminary conclusions were supported by DNA sequence analysis of these and other *A. mellea* and *A. tabescens* samples collected in Spain that were compared with sequences of *Armillaria* species from other geographical locations deposited in GenBank. In this work we describe these atypical populations of *A. mellea* growing in coastal sand dunes of southern Spain associated with *R. monosperma*. These data contribute to an increased understanding of the morphological, ecological and genetic variability within the *A. mellea* complex.

Matherials and methods

Material collected

We examined abundant collections of an ecological variant of *Armillaria mellea* collected in the coast near Tarifa (Cádiz) as well as of several collections of *Armillaria mellea* and *A. tabescens* made along Spain's Mediterranean coastal areas. The materials studied are deposited in the herbaria AH (Universidad de Alcalá, Alcalá de Henares, Madrid) and GDA (Universidad de Granada).

Macromorphological examinations were performed on fresh material. Colour definition is based in Kornerup & Wanscher (1973) and the NBS/IBCC colour system (www.anthus.com/colors/Cent.html). Micromorphological examinations were conducted using Zeiss ×2000 and Nikon Optiphot ×1000 microscopes. Tissues were mounted in KOH (3%) and ammonia red congo (3%). Basidiospores were observed under Field Emission Scanning Electron Microscope (FESEM) Leo (Zeiss) model 1539 Gemini. The samples were submitted to critical point drying, according to the method of Moreno et al (1995).

DNA extraction, PCR amplification, and DNA sequencing

DNA was extracted from small basidiome fragments following previously described methods (Peláez et al 1996). The D1-D2 region of the 28S rDNA was amplified using the LR0R (Hopple & Vilgalys 1984) and NL4 (O'Donnell 1993) primers. The ITS1-5.8S-ITS2 fragments were amplified using the ITS1F (Gardes & Burns 1993) and Ar-1 5' CAA CTC GGA CAG CAA ACG C 3' primers, (the latter derived from sequences of the 28S gene of *A. mellea*). PCR amplifications followed standard procedures (5 m at 93°C, then 40 cycles of 30 s at 93°C, 30 s at 53°C and 2 min at 72°C) using Taq DNA polymerase (QBiogene, Inc.) following the procedures recommended by the manufacturer. Amplification products (0.1 μg/ml) were sequenced using the Big Dye Terminator Cycle Sequencing Kit (Applied Biosystems) following the manufacturer's recommendations. Each strand of all amplification products was sequenced with the same primers used for the initial amplification. Partial sequences obtained during sequencing reactions were assembled using Bioedit 7.0.5.3 (Hall 1999). Sequences were deposited in GenBank with the following accession numbers: EU266540 (partial 28S rDNA, *A. mellea* AH 9328); EU66541 (partial 28S rDNA, *A. mellea* GDA 51999); EU266542 (partial 28S rDNA, *A. mellea* GDA 51998); EU266543 (partial 28S rDNA, *A. tabescens* AH 1285); EU266544 (partial 28S rDNA, *A. tabescens* AH 136); EU266545 (ITS, *A. mellea* AH 9328); EU266546 (ITS, *A. mellea* GDA 51999).

Consensus sequences were aligned using CLUSTAL X (Thompson et al 1997) and the alignments were visually adjusted with GeneDoc 2.5 software (Nicholas et al 1997). Each sequence was compared with GenBank and our own internal database of local accessions using FastA applications (GCG Wisconsin Package, Version 10.3-UNIX, Accelrys Inc.).

Phylogenetic analysis

Bayesian analysis based on Markov chain Monte Carlo (MCMC) approach was run using MrBayes 3.01 (Ronquist & Huelsenbeck 2003). To improve mixing of the chain, four incrementally heated simultaneous Monte Carlo Markov chains were run over 2,000,000 generations. MrModeltest 2.2 (Nylander 2004) was used to perform hierarchical likelihood ratio tests to calculate the Akaike information criterion (AIC) values of the nucleotide substitution models. The model selected by AIC for the alignment of the 28S gene fragment was the GTR+I+G model allowing six classes of substitution types, a portion of invariant alignment positions, and mean substitution rates varying across the remaining positions according to a gamma distribution.. The model selected for the alignment of the ITS region was GTR+G model allowing six classes of substitution types. Priors used for the MCMC process were a Dirichlet distribution for substitution rates and nucleotide frequencies and a uniform prior for the rate parameter of the gamma distribution. Both types of analysis used the sampling frequency of 100 to store trees, with the 1000 first trees discarded to obtain a majority rule consensus tree.

Parsimony analysis was performed on the same sequence alignments following the "New Strategy" described by Quicke et al (2001) using successively the consistency index (CI) and the rescaled consistency index (RC) to index the reweighs, holding the 10 most parsimonious trees with no search time limit for each repetition and performing 100 repetitions. The PAUP executable files were provided by http://www.donnasaxby.

com /nexus.htm. For both sequence alignments, the final trees generated by the "New Strategy" method by reweighing the most parsimonious trees were almost identical in terms of their CI and RC, having the same lengths.

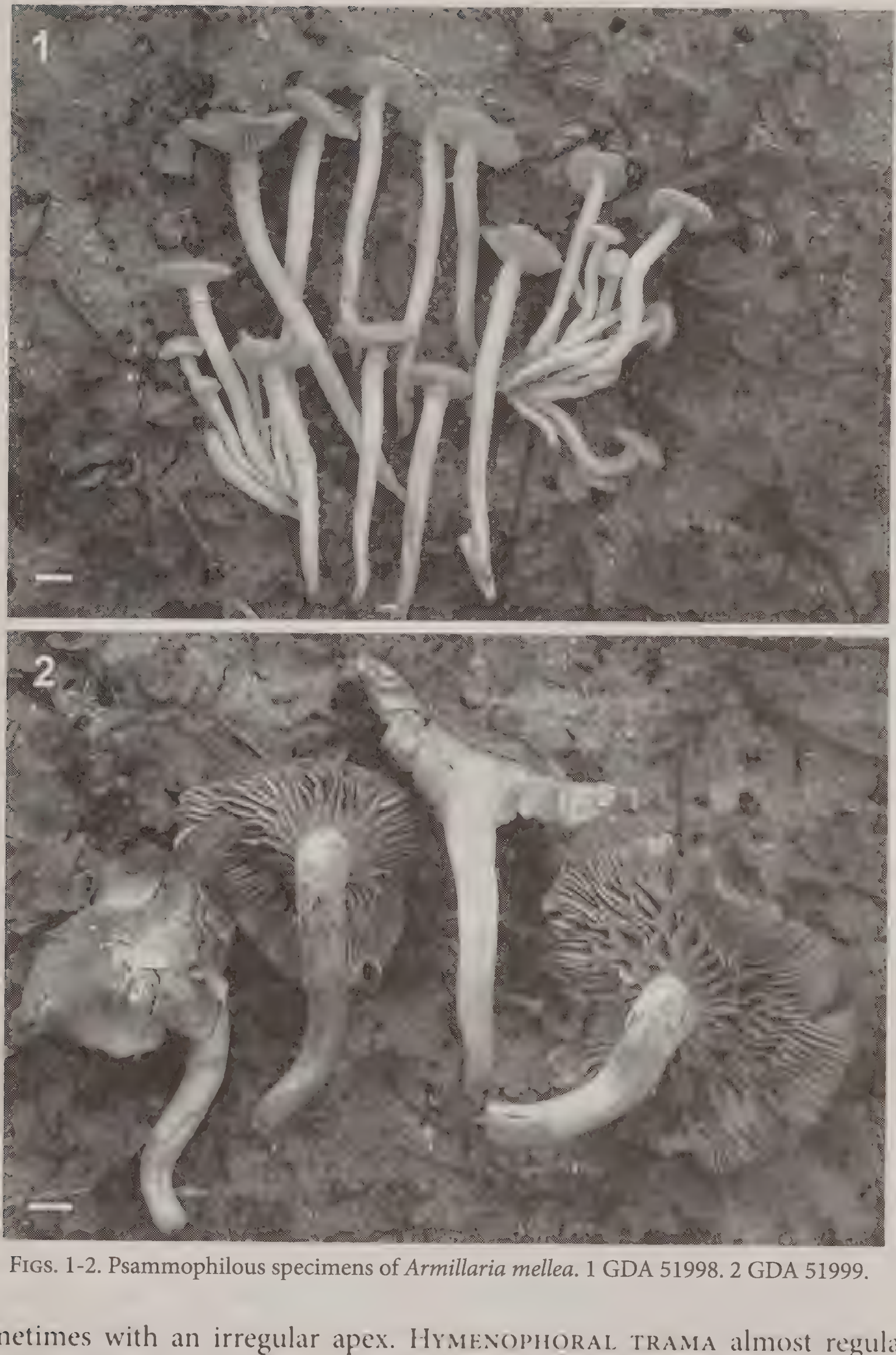
Taxonomy

Psammophilous variants of *Armillaria mellea*:

Collection 1: **(Fig. 1)**

CAP 3–30 mm diam., hemispheric, plano-convex, plane and finally depressed, margin sulcate-fimbriate; greyish greenish yellow (5 C-5; 6 C-5) to pale yellowish green (5 B-4) at the disc, yellowish white (6 B-3; 7 A-2), pale yellowish green (5 B-2) and pale yellowish grey (6 B-3) on the margins, some specimens showing small light olive brown (6 C-8) warts visible only under a hand lens. STIPE 100–120 × 2–8 mm, cylindric-fusiform, tapering towards the base, deeply rooted, merged at the base and prolonged in a pseudorhiza growing deeply into the sand (making it difficult to collect the basidiomata), rigid, surface smooth and white although staining yellowish white (7 A-2) or pale yellowish green (5 B-2; 5 B-4; 6 B-3). ANNULUS not always present, fibrillose, whitish to yellowish (4 A-3; 4 A-5) or orange grey (5 B-2). GILLS subdecurrent or decurrent, relatively distant, white or slightly pinkish grey (9 B-2) when young, dark grayish yellow (6 C-5; 6 D-5) when mature. FLESH compact and fibrous, whitish, without special smell and bitter taste. SPORE PRINT white or very pale.

PILEIPELLIS (Fig. 3A) a cutis of pseudoparenchymatous structure, constituted by a dense layer of thick-walled hyphae (16–28 µm), the superficial cells with endocellular and intraparietal pigment reddish brown (8 C-7; 8 C-4) and pale yellow (4 A-3), the most internal cells hyaline. On the surface some groups of hyphae with free tips cylindrical, clavate or subglobose (18–32 µm). STIPITIPELLIS (Fig. 3D) composed of cylindrical (3–5 µm), parallel, hyaline or with pale yellowish (4 A-3) pigment hyphae, caulocystidia very variable: cylindrical, clavate, subpyriform, utriform, lageniform, branched or diverticulate at the apex, unicellular or septate. ANNULUS (Fig. 3C) constituted by hyphae of thin cell walls, irregular, branched, septate, with some cells enlarged (18–20 µm), hyaline or with a slight yellowish pigment (4 A-3), intracellular or slightly parietal-encrusted. BASIDIOSPORES (Fig. 4) 7.8–9.6 × 6–7.8 µm (Xm = 8.5 × 6.6 µm), subglobose or broadly ellipsoid [Q: l/w = 1.14–1.44 (Qm = 1.29)], with a prominent apiculus, thick-walled and smooth, nonamyloid, with a central guttule, hyaline or pale yellowish (4 A-3). BASIDIA 25–40 × 7–9 µm, grouped in loosed clusters when young (Figs. 3E, 3F), forming a dense palisade when mature (Fig. 3G), cylindrical, 4-spored and without clamp connection at the base, hyaline when young, then but with abundant cellular yellowish pigment. CHEILOCYSTIDIA (Fig. 3H) 20–40 × 6–8(–14) µm, cylindrical, clavate, utriform,



FIGS. 1-2. Psammophilous specimens of *Armillaria mellea*. 1 GDA 51998. 2 GDA 51999.

sometimes with an irregular apex. HYMENOPHORAL TRAMA almost regular, except for the subhymenium, where the hyphae are confusingly disposed (trama divergent).

HABITAT AND DISTRIBUTION. Growing in clusters, on coastal dunes, near *Retama monosperma* and *Ammophila arenaria*, in the province of Cádiz, southern Spain.

Collection 2: **(Fig 2)**

CAP 50–83 mm diam., hemispheric, plano-convex, plane and finally depressed, irregular when mature; light grayish brown (8 D-4) and light brown (7 C-6) at the disc, orange grey (6 B-3) and grayish greenish yellow (4 B-2; 5 B-3) at the rest. Without warts or scales, but some small areas with stronger pigmentation were noted. STIPE 70–110 × 10–15 mm, tapering towards the base, rigid, surface smooth and white, with stains in greenish yellow (3 B-2; 4 C-3), greyish greenish yellow (5 C-6) and light olive (4 E-8), merged at the base but lacking a pseudorhiza. One basidiome showed a well-defined annulus, fibrillose, whitish becoming yellowish (4 A-3; 4 A-5) at the edge. The remaining specimens showed generally poorly defined and incomplete annular zones, fibrillose-cottony to submembranous, greenish yellow (4 B-5). GILLS thick, quite open, subdecurrent to decurrent, yellowish white (7 A-2), but soon becoming yellowish grey (7 B-3) or even light greyish brown (7 D-4). FLESH compact and fibrous, white but becoming orange grey (6 B-2) when exposed to the air, smelling of flour and with a very bitter taste. SPORE PRINT white or very pale.

PILEIPELLIS more intensity coloured than in coll. 1, composed by a dense layer of parallel hyphae (15–29 µm), thick walled, the most superficial ones with a dense intraparietal and intracellular pigment olive (5 E-6), olive grey (6 F-6), reddish brown (8 E-7; 8 C-4) and yellowish (4 A-3). Some superficial hyphae with differentiated tips, cylindrical or clavate (17–30 µm) that were but less frequent and less conspicuous as in coll. 1. STIPITIPELLIS similar to coll. 1 but with the hyphae more greenish yellow (3 A-6; 4 C-5) pigmented and with less numerous caulocystidia. ANNULUS (Fig. 3B) composed by thin-walled, irregular, branched and septate hyphae, rather similar to coll. 1. BASIDIOSPORES similar to coll. 1, but slightly larger, 8–10.3 × 6–8 µm (Xm = 8.9 × 6.8 µm, Q: l/w = 1.2–1.5, Qm = 1.29). BASIDIA (Fig. 3G) 20–43 × 7–10 µm, forming a dense palisade and with abundant cellular yellowish pigment (4 A-6; 4 B-7), without clamps. HYMENOPHORAL TRAMA similar but with sub-hymenium more developed and evident, with confusing structure (trama divergent).

HABITAT AND DISTRIBUTION. Growing in clusters on coastal dunes, at the base of *R. monosperma,* in the province of Cádiz, southern Spain.

SPECIMENS EXAMINED. (COLL. 1): **SPAIN, CÁDIZ: Tarifa,** ENSENADA DE VALDEVAQUEROS, 30STF7590, several populations with numerous fasciculate basidiomata, in coastal sand dunes, near *R. monosperma* and *A. arenaria*, 18 Nov 2005, leg. L. Alcoba and A. Ortega, *GDA 51998*, duplicate in *AH 31895*. (**coll. 2**): a population of eight fasciculate basidiomata, in coastal sand dunes, at the base of a *R. monosperma* trunk, 18 Nov 2005, leg. L. Alcoba and A. Ortega, *GDA 51999*, duplicate in *AH 31896*.

ADDITIONAL MATERIAL EXAMINED: *Armillaria mellea* sensu str.: **SPAIN, MADRID:** PUERTO DE CANENCIA, on stump of *Betula alba*, 10 Nov 1985, leg. F. Esteve-Raventós, det. F. Esteve-Raventós, *AH 9328*. *Armillaria tabescens*: **SPAIN, NAVAS DEL MARQUES:**

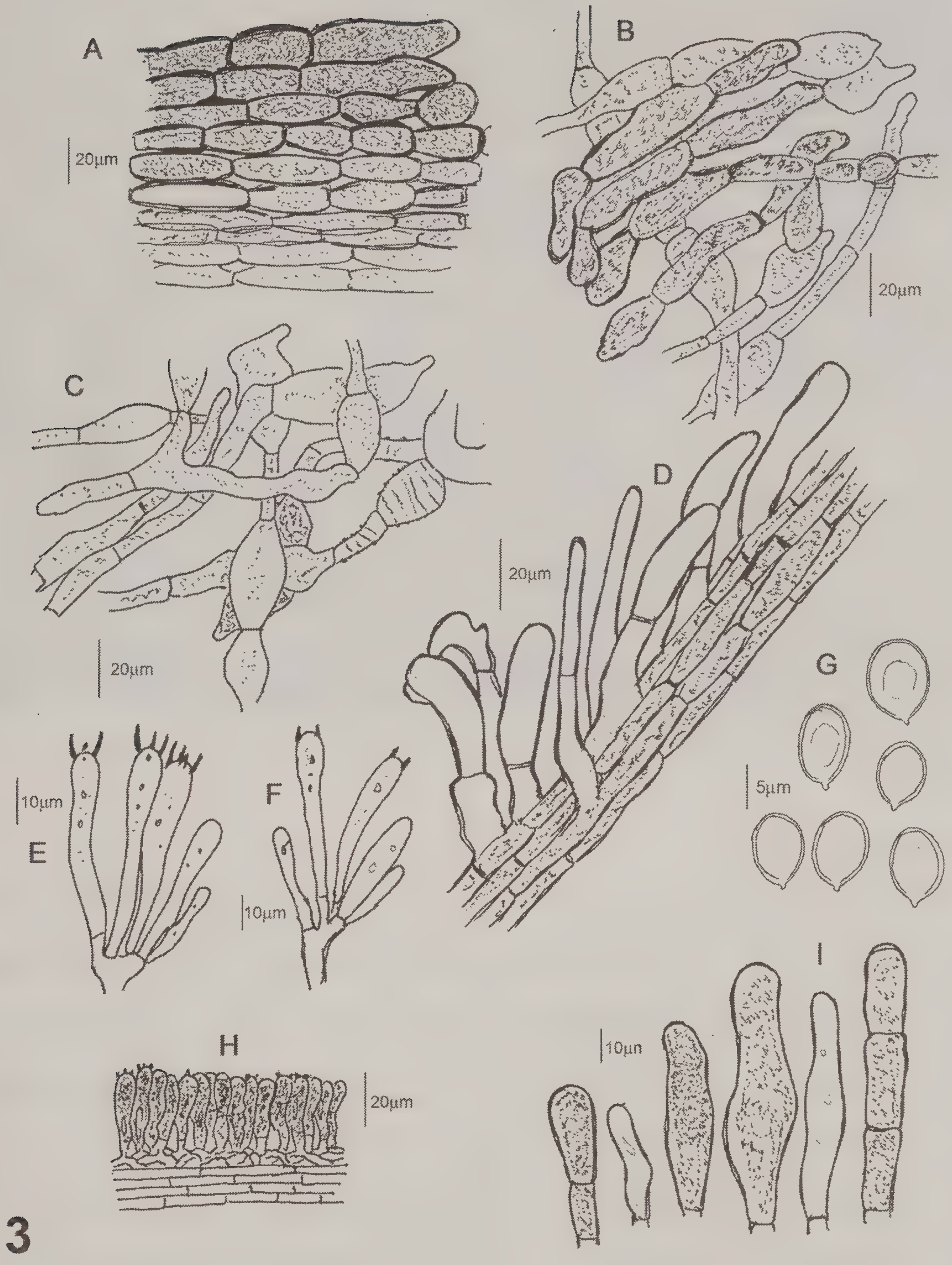

A
20µm
B
20µm
C
20µm
D
20µm
E
10µm
F
10µm
G
5µm
H
20µm
I
10µn
3

FIG. 3. Psammophilous *Armillaria mellea*: A. Structure of the pileipellis GDA 51998. B. Structure of the annulus GDA 51998. C. Structure of the annulus GDA 51999. E. Basidia GDA 51998. F. Basidia GDA 51999. G. Spores. GDA 51998 H. Details of the hymenophore GDA 51998. I. Cheilocystidia GDA 51998.

ÁVILA, 5 Oct 1975, leg. F. García Fernández, *AH 136*; idem, UBRIQUE (**CÁDIZ**), 4 Oct 1976, leg. & det. G. Moreno, *AH 1285*.

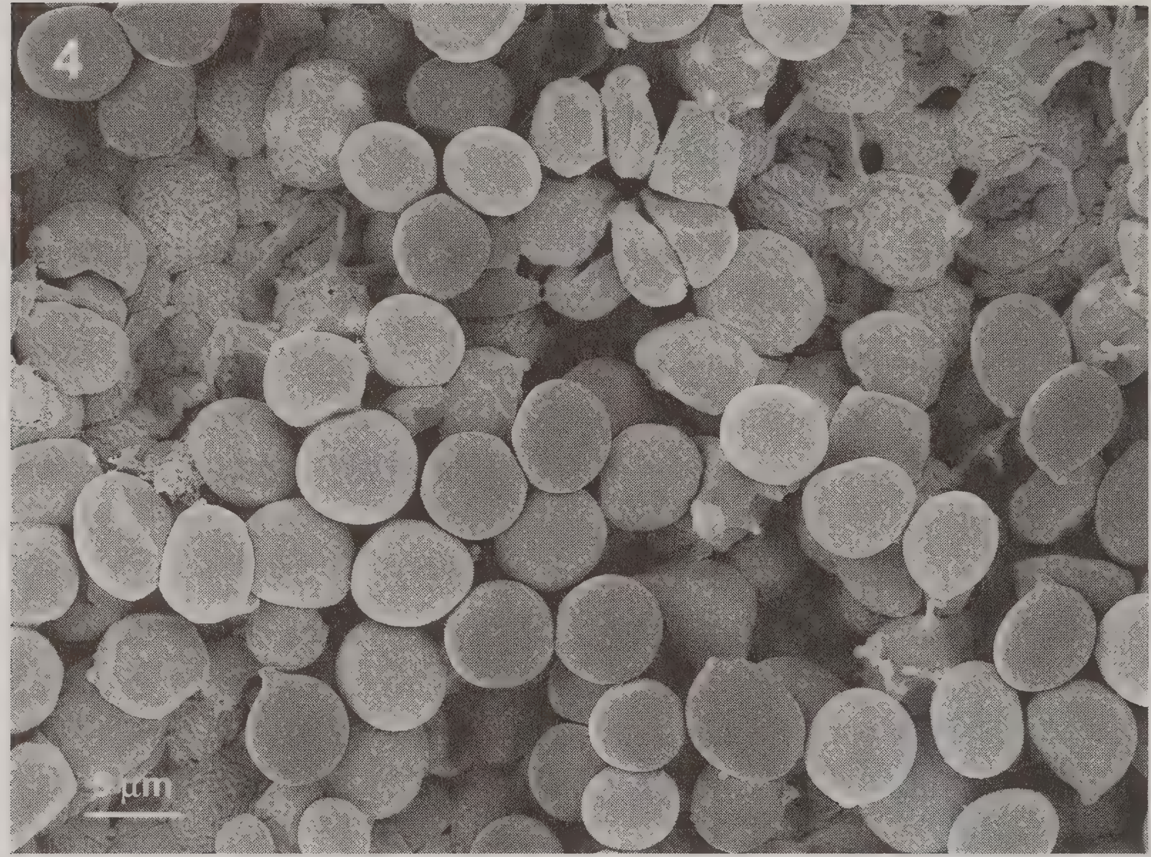


Fig. 4. Psammophilous *Armillaria mellea* GDA 51999. Spore details under the scanning electronic microscope.

Molecular analysis

The D1-D2 regions of the 28S rRNA gene were successfully amplified and sequenced for all specimens selected. DNA fragments measured 615 bp. The two samples of psammophilous *A. mellea* GDA 51998 and GDA 51999 showed identical sequences in this region, and their closest matches in GenBank were with sequences of *A. mellea* sensu str. The sequence of *A. mellea* sensu str. AH 9328 showed an almost 100% homology (only one base difference out of 570 bases) with one sequence from Germany (AY207144). Likewise, the two *A. tabescens* sequenced (AH 1285 and AH 136) were 100% homologous with two GenBank *A. tabescens* sequences (AY213589 and AY213588). One majority rule consensus tree using Bayesian analysis was obtained from the alignment of the D1-D2 sequences from several *Armillaria* species, as noted in 'Materials and methods'. Of the 590 characters aligned, 461 were constant.

The resulting phylogenetic tree (Fig. 5) showed a clade containing all the sequences of *A. mellea* with relatively high clade credibility (87%), separated from the rest of *Armillaria* species. The two sequences of psammophilous *A. mellea* appeared together with two strains of *A. mellea* sensu str. from Europe from Germany and Spain, within a branch with 100% statistical support. The two *A. mellea* sensu str. strains were grouped in a branch with high statistical support (98%), whereas the sequences of the two psammophilous specimens were grouped in a sister clade without statistical support. A second branch with very high clade credibility (99%), containing sequences from *A. mellea* from North America, appeared as a sister group of the European sequences.

A large branch with low clade credibility (55%) contained the rest of *Armillaria* species. The strains of *A. tabescens* were separated from the remaining species in a branch without statistical support, together with a sequence of *A. affinis* (Singer) T.J. Volk & Burds. rooted in a basal position. The rest of the species in the tree were grouped in a branch with moderate support (70%). All those species were poorly resolved and most of the internal branches lacked any statistical support. Parsimony analysis of the same alignment generated a tree showing essentially the same topology, the only exception being that *A. affinis* was rooted at the base of the *A. mellea* clade (not shown).

The relationships between the new taxon and the *A. mellea* complex were further investigated by sequencing the ITS1-5.8S-ITS2 region. We obtained full ITS sequences from the psammophilous *A. mellea* GDA 51999 and *A. mellea* sensu str. AH 9328. The size of the amplified fragments was of 767–915 bp. The sequence of the specimen GDA 51998 could not be analyzed in detail because of the low quality of the raw data, probably due to contamination by a second fungus, but at least the ITS1 region was identical to that of GDA 51999, suggesting their conspecificity. Similarity between specimens AH 9328 and GDA 51999 was 98%. Their sequences differed in seven transitions and in the presence of a motif AGCGG repeated in the position 117 of the ITS1 region in *A. mellea* GDA 51999.

These sequences were aligned with a group of *A. mellea* sequences from diverse geographic origins, retrieved from GenBank. A total of 850 bp were aligned, 552 of which were constant. Bayesian analysis of the alignment was used to build the phylogenetic tree shown in Fig. 6. The *A. mellea* isolates were grouped according to their geographic origin, with four main clusters with high statistical support including sequences from Asia, Europe, West North America and East North America, respectively. All American specimens were grouped on a branch with moderate statistical support (69%). The strains from Asia appeared as a sister group to the European clade, although this branch lacked any statistical support. The clade containing the European strains included also one isolate from Iran and two from South Africa, as well as two sequences of uncertain origin. The sequence of *A. mellea* sensu str. AH 9328 was grouped together with the rest of European specimens, whereas the sequence of the psammophilous *A. mellea* GDA 51999 was separated in a basal position in the clade. All the sequences of *A. mellea* from Europe, excluding the specimen GDA 51999 and a strain of uncertain origin EF637086, formed a monophyletic group with high support (96%). The phylogenetic tree constructed by parsimony analysis showed identical topology (not shown).

Discussion

Correct identification of members of the *Armillaria mellea* group is complicated by the large variability of the macro- and micro-morphological features, as well as by their ample ecological spectrum (Coetzee et al 2000, Cox et al 2006); therefore, several variants or species might be recognized depending on substrates or geographic origins (Watling et al 1982). This justifies using different techniques to delimit the different taxa. Kile & Watling (1983) suggested that macro-morphological features are taxonomically more relevant than micro-morphological ones. Besides the traditional morphological approaches, sexual compatibility studies have developed the concept of biological species, leading to the description of as many as ten mating types in North America, five in Europe, and a few others in Asia that — in most cases — have been matched with morphological species (Volk & Burdsall 1995). More recently, molecular techniques have been used to identify *Armillaria* species (e.g. Coetzee et al 2000, 2001, 2003, 2005, Mwenje et al 2003, 2006). Other approaches include isozyme analysis of pectic enzymes (Mwenje et al 2006) and fatty acid methyl esters (FAMEs) analysis (Cox et al 2006).

The psammophilous fungi studied in this work are morphologically close to *A. mellea* sensu str., but several characters distinguish them:

> 1.- Lack of defined universal veil remains (warts) over the pileus surface. (In contrast, typical *A. mellea* shows well-differentiated warts.)
>
> 2.- An evanescent and fibrillose or fibrillose-cottony annulus that is always poorly developed or reduced to some remains over the stipe surface. (In *A. mellea* sensu str. the annulus is always conspicuous and membranous with scales common on the stipe below the ring.)
>
> 3.- Slightly larger basidiospores: 7.8–10.3 × 6–8 µm (Xm = 8.5–8.9 × 6.6–6.8 µm) vs — for *A. mellea* sensu str. — 7.1–8.7 × 5.4–6.4 µm (Breitenbach & Kränzlin 1991), 7.2–8.9 × 5.6–6.7 µm (Watling et al 1982), and (6–)7–8.5(–11) × 5–6(–7.5) µm (Termorshuizen 1995). Also, basidiospores are sometimes pale yellow instead of hyaline, as in *A. mellea* sensu str.

In addition, our coast dunes collections differ in ecology from *A. mellea* sensu str., a taxon widely distributed in the Northern Hemisphere, growing over many different substrates (Coetzee et al 2000, 2001). To our knowledge there are no reports of *A. mellea* growing associated with *Retama monosperma*, a species colonizing coastal dunes in the southwestern Iberian Peninsula and northwestern Morocco (Talavera 1999).

These collections could also be confused with *A. tabescens*, a frequent species in Mediterranean habitats, which we have collected on trunks and roots of sclerophyllous *Quercus* and *Cistus ladanifer* L. However, the conspicuous scales on the cap surface and the lack of ring in *A. tabescens* represent clear morphological differences.

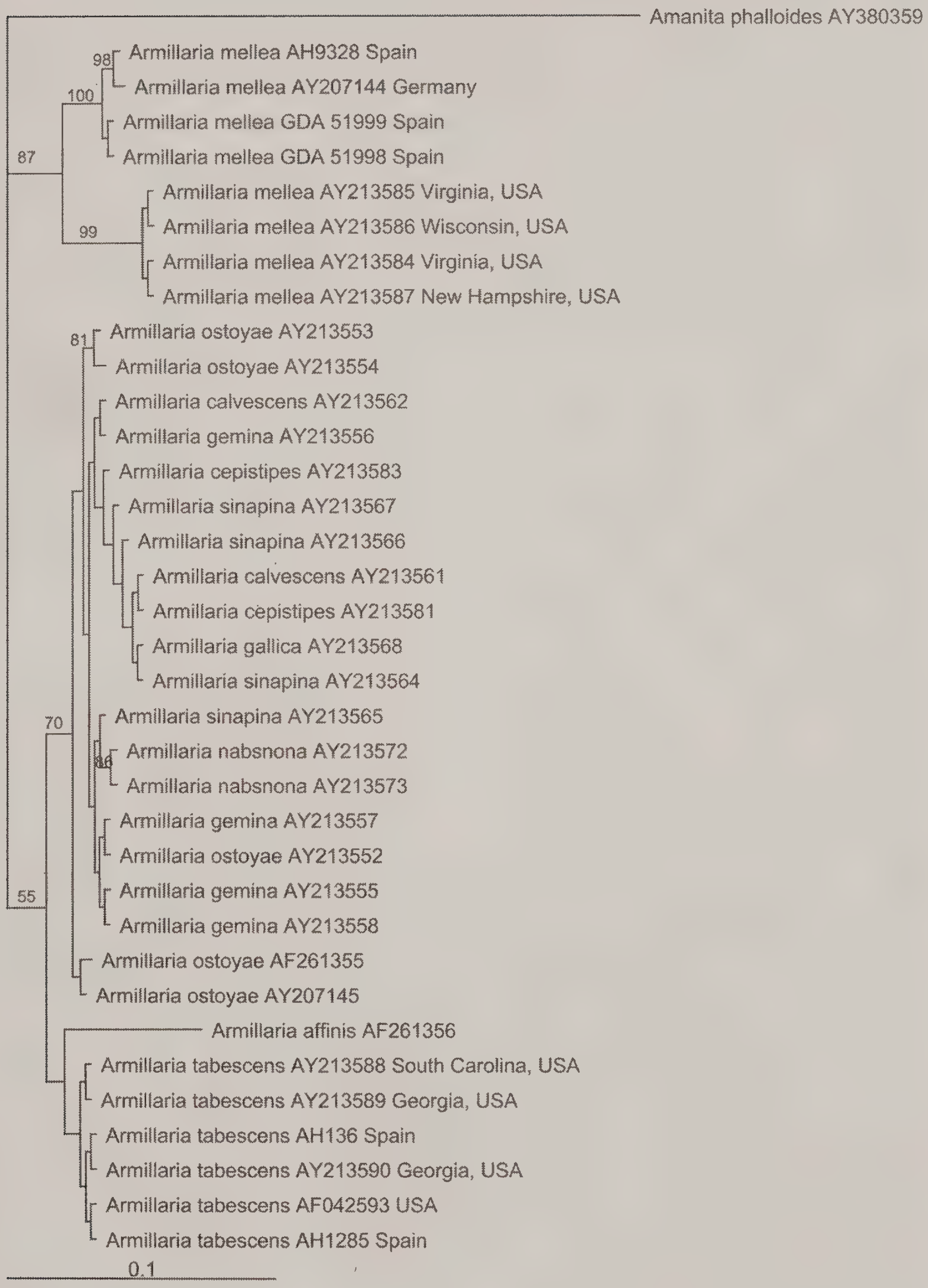

Amanita phalloides AY380359
98
Armillaria mellea AH9328 Spain
Armillaria mellea AY207144 Germany
100
Armillaria mellea GDA 51999 Spain
87
Armillaria mellea GDA 51998 Spain
Armillaria mellea AY213585 Virginia, USA
Armillaria mellea AY213586 Wisconsin, USA
99
Armillaria mellea AY213584 Virginia, USA
Armillaria mellea AY213587 New Hampshire, USA
81
Armillaria ostoyae AY213553
Armillaria ostoyae AY213554
Armillaria calvescens AY213562
Armillaria gemina AY213556
Armillaria cepistipes AY213583
Armillaria sinapina AY213567
Armillaria sinapina AY213566
Armillaria calvescens AY213561
Armillaria cepistipes AY213581
Armillaria gallica AY213568
Armillaria sinapina AY213564
70
Armillaria sinapina AY213565
Armillaria nabsnona AY213572
Armillaria nabsnona AY213573
Armillaria gemina AY213557
Armillaria ostoyae AY213552
55
Armillaria gemina AY213555
Armillaria gemina AY213558
Armillaria ostoyae AF261355
Armillaria ostoyae AY207145
Armillaria affinis AF261356
Armillaria tabescens AY213588 South Carolina, USA
Armillaria tabescens AY213589 Georgia, USA
Armillaria tabescens AH136 Spain
Armillaria tabescens AY213590 Georgia, USA
Armillaria tabescens AF042593 USA
Armillaria tabescens AH1285 Spain
0.1

FIG. 5. Phylogenetic tree of *Armillaria* species based on sequences of the D1-D2 domains of the 28S rRNA gene, generated by Bayesian analysis, using *Amanita phalloides* as outgroup. The clade credibility values are indicated at the nodes. The scale bar shows the nucleotide substitution rate.

In agreement with these data, the phylogenetic analysis of the D1-D2 region of the 28S rRNA gene (Fig. 5) showed specimens GDA 51998 and GDA 51999 clustered far apart from *A. tabescens* and supported their kinship with *A. mellea*. The sequences derived from *A. mellea* sensu str. and our specimens constituted a monophyletic group apart from a large clade containing the rest of *Armillaria* species analyzed. Moreover, they consistently grouped in a clade with two European *A. mellea* isolates with total statistical support and in a sister group to some American isolates. The two psammophilous collection sequences were identical, strongly suggesting that they do, in fact, represent the same taxon even though their grouping together in a clade lacks statistical support.

Our phylogenetic tree adds additional sequences from *A. affinis, A. mellea,* and *A. tabescens* to the sequences analyzed by Kim et al (2006); its topology is consistent with the analysis reported by those authors. Within the large clade containing the *Armillaria* species excluding *A. mellea*, the *A. tabescens* strains were rooted as a basal group, although without statistical support, suggesting that this species is relatively distant from other members of the genus. Contrary to *A. mellea* (as discussed below), the *A. tabescens* sequences were not arranged in the tree following any geographical pattern, and the strains from Spain intermingled with those from North America.

Although the D1-D2 region of the 28S rRNA gene has been widely used to study phylogenetic relationships in agaric fungi (e.g. Hopple & Vilgalys 1994, Kim et al 2006), resolution was relatively low, because the sequences analyzed were too similar. Also, there are relatively few *A. mellea* D1-D2 sequences deposited in GenBank. As shown, the phylogenetic analysis based on this region did not segregate completely the two psammophilous specimens from other *A. mellea* sequences. The ITS region has been previously used to assess the geographic diversity within the *A. mellea* complex (Coetzee et al 2000, 2001). Therefore, to further clarify the relationships of these specimens within the *A. mellea* complex, their ITS sequences were obtained and compared with a large number of *A. mellea* sequences from GenBank.

The ITS-based phylogenetic tree (Fig. 6) showed a distribution basically consistent with their geographic origin, with four main clusters containing the sequences coming from Asia, Europe, West and East North America respectively. This distribution agrees with data reported by other authors on a shorter number of sequences (Coetzee et al 2000, 2001). Geographic segregation of *A. mellea* has been confirmed by sequencing of the IGS-1 (Coetzee et al 2000, 2001) and the EF1α (Maphosa et al 2006). The separation of isolates into geographic groups has been interpreted as reflecting genetically distinct sibling species in a process of allopatric speciation (Coetzee et al 2000, Maphosa et al 2006). Some of these non-European variants of *A. mellea* are known to show morphological differences with *A. mellea* sensu str. Thus, *A. mellea* subsp. *nipponica* J.Y. Cha &

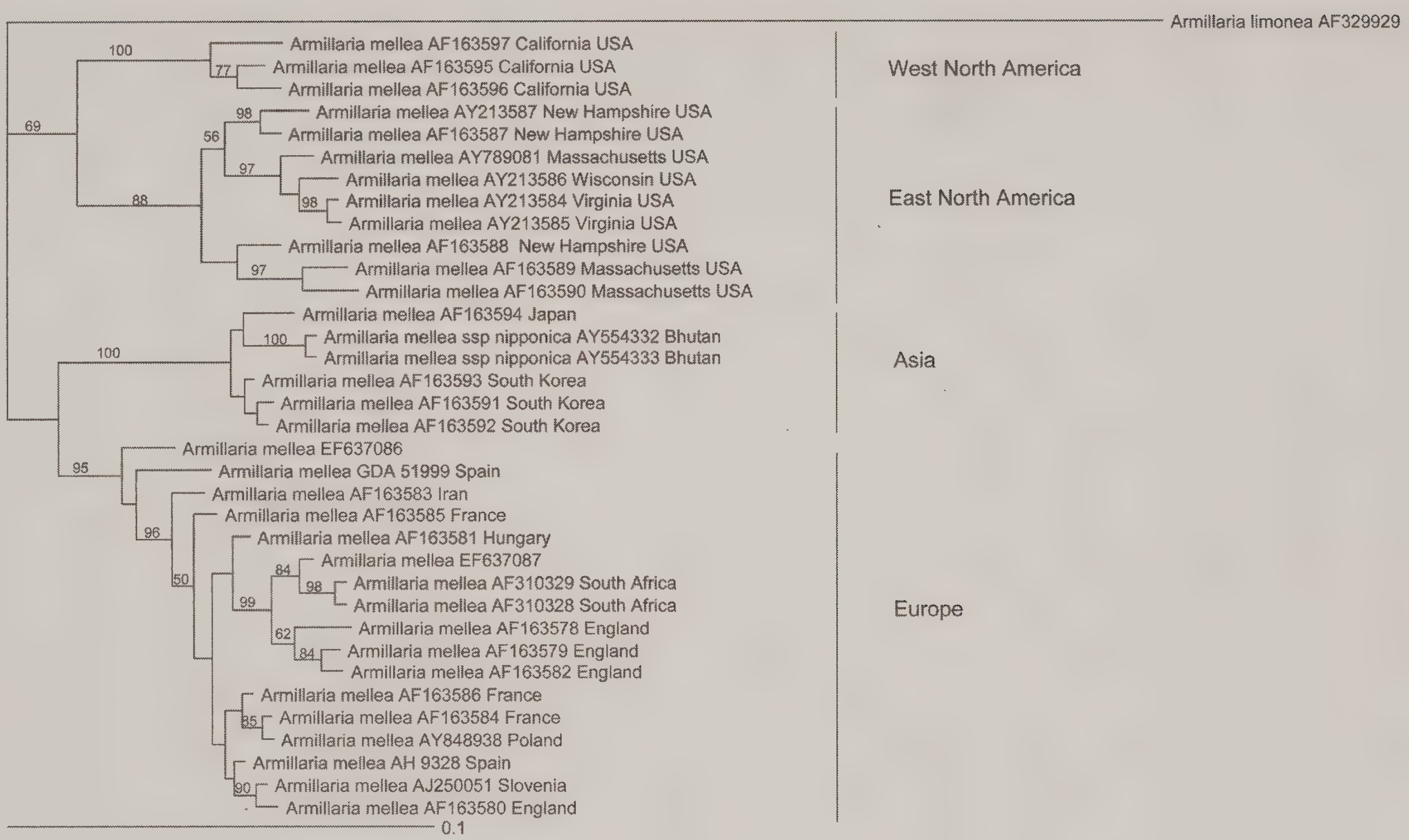

Armillaria limonea AF329929
100
Armillaria mellea AF163597 California USA
77
Armillaria mellea AF163595 California USA
Armillaria mellea AF163596 California USA
West North America
69
98
Armillaria mellea AY213587 New Hampshire USA
56
Armillaria mellea AF163587 New Hampshire USA
97
Armillaria mellea AY789081 Massachusetts USA
Armillaria mellea AY213586 Wisconsin USA
88
98
Armillaria mellea AY213584 Virginia USA
Armillaria mellea AY213585 Virginia USA
East North America
Armillaria mellea AF163588 New Hampshire USA
97
Armillaria mellea AF163589 Massachusetts USA
Armillaria mellea AF163590 Massachusetts USA
Armillaria mellea AF163594 Japan
100
Armillaria mellea ssp nipponica AY554332 Bhutan
100
Armillaria mellea ssp nipponica AY554333 Bhutan
Asia
Armillaria mellea AF163593 South Korea
Armillaria mellea AF163591 South Korea
Armillaria mellea AF163592 South Korea
Armillaria mellea EF637086
95
Armillaria mellea GDA 51999 Spain
Armillaria mellea AF163583 Iran
Armillaria mellea AF163585 France
96
Armillaria mellea AF163581 Hungary
84
Armillaria mellea EF637087
50
98
Armillaria mellea AF310329 South Africa
99
Armillaria mellea AF310328 South Africa
Europe
62
Armillaria mellea AF163578 England
84
Armillaria mellea AF163579 England
Armillaria mellea AF163582 England
Armillaria mellea AF163586 France
85
Armillaria mellea AF163584 France
Armillaria mellea AY848938 Poland
Armillaria mellea AH 9328 Spain
90
Armillaria mellea AJ250051 Slovenia
Armillaria mellea AF163580 England
0.1

Fig. 6. Phylogenetic tree of the *Armillaria mellea* group based on the sequences of the ITS1-5.8S-ITS2 region, generated by Bayesian analysis, using *A. limonea* as outgroup. The clade credibility values are indicated at the nodes. The scale bar shows the nucleotide substitution rate.

Igarashi differs in having conspicuous yellowish mature gills that are decurrent to falcate-decurrent. Also, basidiospores are significantly larger (10–13.5 × 6–8 µm) than in *A. mellea* sensu str. (Cha & Igarashi 1995). In contrast, *A. mellea* sensu str. from North America (corresponding to the mating incompatibility group NABS VI) shows very similar morphology to its European counterpart (Motta & Korhonen 1986, Bérubé & Dessureault 1989).

The *A. mellea* AH 9328 collected in Spain was grouped with the rest of European sequences, as expected. In contrast, the psammophilous specimen of *A. mellea* GDA 51999 appeared in a basal position with respect to the European clade. The branch containing all the European isolates, excluding our psammophilous specimen and another sequence of uncertain geographic origin (EF637086), was well supported (96% clade credibility). This supports the idea that although our specimen is clearly within the *A. mellea* complex, it could be considered in the future with a taxonomic status different to the rest of European strains.

Within the European clade there were two sequences from strains of unclear geographic origin. These two sequences (EF637086 and EF637087) appear in GenBank related with an unpublished article on *A. mellea* in Azerbaijan, so it is tempting to speculate that at least one of the two sequences, or both, could have this geographic origin. The European clade included also strains from South Africa and Iran. These two South African isolates had already been shown to be closely related to European *A. mellea* sensu str. by sequencing of the ITS and IGS-1 regions, implying that the fungus was introduced by early Dutch settlers in Cape Town in mid to late 1600s (Coetzee et al 2001). No further segregation of sequences was observed within this European clade, although three of the isolates from England were grouped on a highly supported (99%) branch closely related to the South African strains and one strain (EF637087) of uncertain origin but separated from the remaining European strains.

With respect to the remaining isolates analyzed, it is interesting to note that the American specimens occurred on one branch as a monophyletic group, although with modest (69%) statistical support. This differs with the analyses by Coetzee et al (2000, 2001) where isolates from the East and West American coasts apparently did not share a common ancestor. The difference could be due to the inclusion of additional strains in our analysis. However, this conclusion is to be taken with caution, considering the limited statistical support of this clade.

In conclusion, we have described an atypical variant of *A. mellea* based on morphological, ecological and molecular phylogenetic evidence. The particular habitat of this taxon could have resulted in an ecological and physical isolation with respect to other populations of *A. mellea*, eventually leading to genetic isolation. The relatively subtle morphological and molecular differences would suggest that the psammophilous variant of *A. mellea* could be in the beginning stages of speciation.

Acknowledgments

We express our gratitude to M. Contu, M. Castro and D.W. Mitchell for the revision of the manuscript and wish to thank Dr. J.D. Bueno and A. González of the Electron Microscopy Service of the University of Granada for their invaluable help with the SEM, as well as to the curators of the herbaria AH (Dr. J. Rejos) and GDA (Dr. M.T. Vizoso).

Literature cited

Bérubé JA, Dessureault M. 1989. Morphological studies of the *Armillaria mellea* complex: two new species, *A. gemina* and *A. calvescens*. Mycologia 81: 216-225.

Breitenbach J, Kränzlin F. 1991. Champignons de Suisse. Vol. 3. Bolets et champignons à lames 1ère. partie. *Strobilomycetaceae* et *Boletaceae, Paxillaceae, Gomphidiaceae, Hygrophoraceae, Tricholomataceae, Polyporaceae* (lamellées). Edition Mykologia. Lucerne.

Cha JY, Igarashi T. 1995. A note on *Armillaria mellea* subsp. *nipponica* subsp. nov. in Japan. Mycoscience 36: 143-146.

Coetzee MPA, Wingfield BD, Harrington TC, Dalevi D, Couthinho TA, Wingfield MJ. 2000. Geographical diversity of *Armillaria mellea* s.s. based on phylogenetic analysis. Mycologia 92: 105-113.

Coetzee MPA, Wingfield BD, Harrington TC, Steimel J, Couthinho TA, Wingfield MJ. 2001. The root fungus *Armillaria mellea* introduced into South Africa by early Dutch settlers. Mol Ecol 10: 387-396

Coetzee MPA, Wingfield BD, Bloomer P, Ridley GS, Wingfield MJ. 2003. Molecular identification and phylogeny of *Armillaria* species from South America and Indo-Malaysia. Mycologia 95: 285-293.

Coetzee MPA, Wingfield BD, Bloomer P, Wingfield MJ. 2005. Phylogenetic analysis of DNA sequences reveal species partitions amongst isolates of *Armillaria* from Africa. Mycol Res 109: 1223-1234.

Cox KD, Scherm H, Riley MB. 2006. Characterization of *Armillaria* spp. from peach orchards in the southeastern United States using fatty acid methyl ester profiling. Mycol Res 110: 414-422.

Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes-application to the identification of mycorrhizae and rusts. Mol Ecol 2: 113-118.

Hall TA. 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucleic Acids Symp Ser 41: 95-98.

Hopple JS Jr, Vilgalys R. 1994. Phylogenetic relationships among coprinoid taxa and allies based on data from restriction site mapping of nuclear rDNA. Mycologia 86: 96–107.

Kile GA, Watling R. 1983. *Armillaria* species from south-eastern Australia. Trans Br Mycol Soc 81: 129-140.

Kim M-S, Klopfenstein NB, Hanna JW, McDonald GI. 2006. Characterization of North American *Armillaria* species: genetic relationships determined by ribosomal DNA sequences and AFLP markers. For Path 36: 145-164.

Korhonen K. 1978. Interfertility and clonal size in the *Armillaria mellea* group. Karstenia 18: 31-42.

Kornerup A, Wanscher JH. 1973. Petit lexique des couleurs. Musterschmidt. Zürich. Frankfurt.

Kühner R, Romagnesi H. 1953. Flore analytique des Champignons supérieurs. Masson et cie. éditeurs. Paris. 557 pp.

Marxmüller H. 1992. Some notes on the Taxonomy and Nomenclature of five European *Armillaria* species. Mycotaxon 44: 267-274.

Maphosa L, Wingfield BD, Coetzee MPA, Mwenje E, Wingfield MJ. 2006. Phylogenetic relationships among *Armillaria* species inferred from partial elongation factor 1-alpha DNA sequence data. Austral Plant Pathol 35: 513-520.

Moreno G, Altés A, Ochoa C, Wright JE. 1995. Contribution to the study of the *Tulostomataceae* in Baja California. Mexico. Mycologia 87: 96-120.

Motta JJ, Korhonen K. 1986. A note on *Armillaria mellea* and *Armillaria bulbosa* from the middle Atlantic states. Mycologia 78: 471-474.

Mwenje E, Wingfield BD, Coetzee MPA, Wingfield MJ. 2003. Molecular characterization of *Armillaria* species from Zimbabwe. Mycol Res 107: 291-296.

Mwenje E, Wingfield BD, Coetzee MPA, Nemato H, Wingfield MJ. 2006. *Armillaria* species on tea in Kenya identified using isozyme and DNA sequence comparisons. Plant Pathol 55: 343-350.

Nicholas KB Jr, Deerfield DW. 1997. GeneDoc: Analysis and Visualization of Genetic Variation. EMBNEW NEWS 4: 14.

Nylander JA. 2004. MrModeltest v2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.

O'Donnell K. 1993. *Fusarium* and its near relatives. 225-233, in DR Reynolds, JW Taylor (eds), The fungal holomorph: mitotic, meiotic and pleomorphic speciation in fungal systematics. CAB international, Wallingford, U.K.

Peláez F, Platas G, Collado J, Díez MT. 1996. Infraspecific variation in two species of aquatic hyphomycetes, assessed by RAPD analysis. Mycol Res 100: 831-837.

Quicke DLJ, Taylor J, Purvis A. 2001. Changing the landscape: a New Strategy for estimating large phylogenies. Syst Biol 50: 60-66.

Ronquist F, Huelsenbeck JP. 2003. MRBAYES 3: Bayesian phylogenetic inference under mixed models. Bioinformatics 19: 1572-1574.

Singer R. 1956. The *Armillariella mellea* group. Lloydia 19: 176-178.

Talavera S. 1999. *Retama*. in S Talavera et al. (eds.), Flora Ibérica. Plantas vasculares de la Península Ibérica y Baleares. Vol. 8 (1). *Leguminosae* (partium). Real Jardín Botánico, CSIC. Madrid.

Termorshuizen AJ, Arnolds E. 1987. On the nomenclature of the European species of the *Armillaria mellea* group. Mycotaxon 30: 101-116.

Termorshuizen AJ. 1995. *Armillaria*. in C Bas et al. (eds), Flora Agaricina Neerlandica, vol. 3. A. General part. B. Taxonomic part: *Tricholomataceae* (2). A.A. Balkema. Rotterdam/Brookfield.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The Clustal_X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res 25: 4876-4882.

Volk TJ, Burdsall HH Jr. 1995. A nomenclatural study of *Armillaria* and *Armillariella* species (*Basidiomycotina, Tricholomataceae*). Synopsis Fungorum 8. Fungiflora. Oslo.

Watling R, Kile GA, Gregory NM. 1982. The genus *Armillaria*-nomenclature, typification, the identity of *Armillaria mellea* and species differentiation. Trans Br mycol Soc 78: 271-285.

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Macrofungal diversity of Uşak province in Turkey

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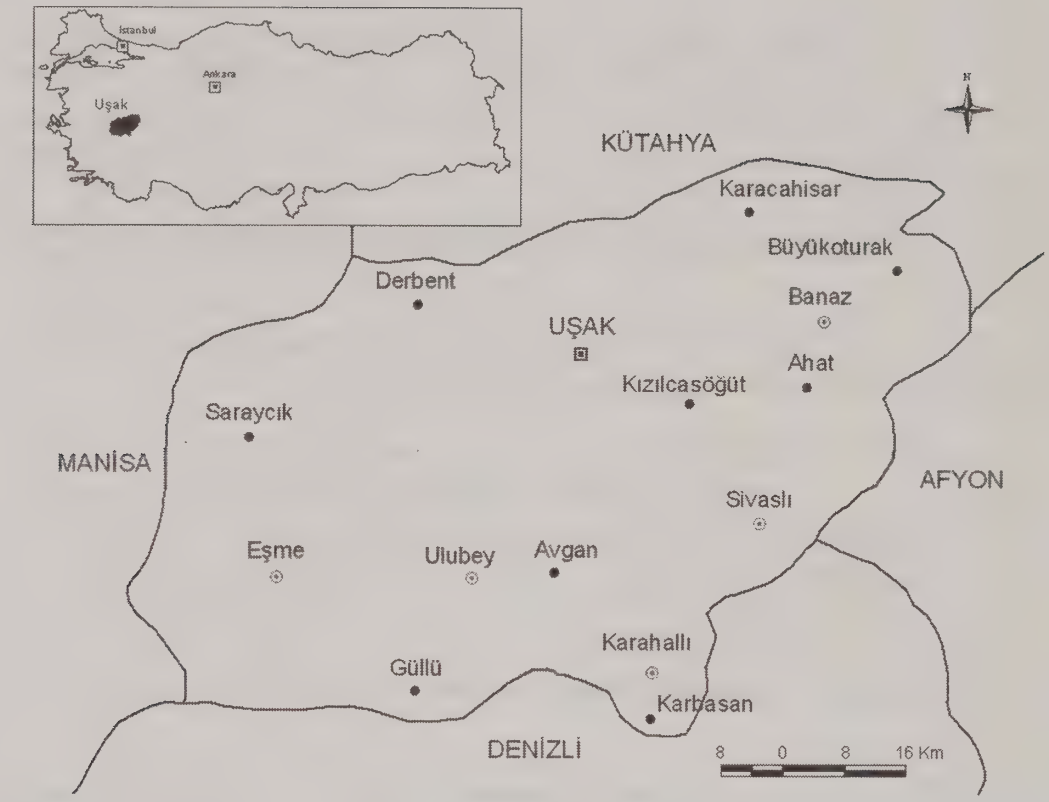
Abstract—This paper was based on macrofungal specimens collected from Uşak, in years of 2006–2007. Field and laboratory studies revealed a total of 124 taxa belonging to 36 families and 2 classes. 11 taxa belong to *Ascomycetes* and 113 to *Basidiomycetes*. Nine of them; *Coprinopsis echinospora, Cystoderma simulatum, Hohenbuehelia semi-infundibuliformis, Hygrophorus capreolarius, Inocybe leucoblema, Leucocoprinus lanzonii, Marasmius chordalis, Mycena renati*, and *Russula rhodopus* are new records for Turkey. A complete report is available at
http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon08-002.pdf

Key words—biodiversity, *Ascomycota, Basidiomycota*

Introduction

The plant flora of Turkey is well-known, but it has been evident from the literature that macrofungal flora of Turkey is far from being well documented (Solak et al. 2007). Each investigation in this subject will aid to illuminate macrofungal flora of Turkey, and our aim in this study is to contribute to this process. Uşak is a province, located in the western part of Turkey, bordered by Denizli on the south, Kütahya on the north, Manisa on the west, and Afyonkarahisar on the east (Figure 1). The climate of Uşak province is Mediterranean-alpine and semi-dry terrestrial type. The annual average temperature is 12.3°C and the annual rainfall is about 540 mm (http://www.klimadiagramme.de/Europa/usak.html). The investigated area is a natural habitat of number of trees, dominant forest plants, such as *Pinus brutia, Pinus nigra, Pinus nigra* subsp. *pallasiana, Pinus sylvestris, Juniperus excelsa, Juniperus foetidissima, Juniperus oxycedrus* var. *oxycedrus, Quercus coccifera, Quercus ilex, Quercus ithaburensis* ssp. *macrolepis,*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Ankara
Uşak
KÜTAHYA
Karacahisar
Büyükoturak
Banaz
Derbent
UŞAK
Ahat
Kızılcasöğüt
Saraycık
MANİSA
AFYON
Sivaslı
Eşme
Ulubey
Avgan
Karahallı
Güllü
Karbasan
DENİZLİ
8 0 8 16 Km
N

Figure. Collection areas.

Platanus orientalis, *Tilia* sp., *Cornus* sp., *Acer* sp., *Carpinus* sp., *Salix* sp., *Styrax officinalis, Vitex agnus*, and *Pistacia terebinthus*. The study area's climate and vegetation are favourable for macrofungi. The aim of this study is to determine macrofungi species in the research area and thus provide more data on the macrofungi of Turkey.

Materials and methods

Macrofungi were collected in Uşak between 2006 and 2007. The field studies were conducted mostly in autumn and spring, since during these periods the climatic conditions are most suitable for carpophore formation. Relevant morphological and ecological characteristics of the macrofungi were recorded and photographed in their natural habitats. The local consumption of macrofungi and their local names were recorded by interviewing local people. Then they were carried to the laboratory for further investigation. Spore prints were prepared and spores photographed. Some reagents (Melzer's reagent, 5% KOH, H_2SO_4, cotton blue, etc.) were used for identification. The specimens were identified by examining their macroscopic and microscopic features, using references by Breitenbach & Kränzlin (1984-2000), Bresinsky & Besl (1990), Capelli (1984), Ellis & Ellis (1990), Marchand (1971-1986), Moser (1983), Pacioni (1985), Phillips (1981), Watling (1982) and Watling & Gregory (1987, 1989). Taxa were assigned to classes and families according to CABI Bioscience Databases (2007). Dried specimens were numbered and placed in sealed bags. In addition they were put into a deep freeze for a week to protect against internal and external parasite attacks. All collected specimens are now deposited at Pamukkale University, Education Faculty, Science Department Laboratory, in Denizli.

Results

In our study 124 taxa belonging to 36 families were identified. These taxa are presented with their localities, habitats, collection dates and accession numbers. The new records are presented with their descriptions. All taxa are listed in alphabetical order in the full checklist posted at http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon08-002.pdf

Discussion

In this study, 124 macrofungi taxa belonging to 36 families collected from Uşak province were reported. Eleven (9%) of the taxa belong to *Ascomycetes* and 113 (91%) to *Basidiomycetes.*

The distribution of the taxa and their families are: *Tricholomataceae* 20, *Agaricaceae* 16, *Mycenaceae* 7, *Russulaceae* 7, *Pluteaceae* 6, *Psathyrellaceae* 6, *Lycoperdaceae* 5, *Morchellaceae* 5, *Polyporaceae* 5, *Hygrophoraceae* 4, *Hymenochaetaceae* 3, *Boletaceae* 3, *Marasmiaceae* 3, *Pleurotaceae* 3, *Bolbitiaceae* 2, *Geastraceae* 2, *Helvellaceae* 2, *Inocybaceae* 2, *Pyronemataceae* 2, *Rhizopogonaceae* 2, *Stereaceae* 2, *Strophariaceae* 2, *Suillaceae* 2, *Astraeaceae* 1, *Crepidotaceae* 1, *Discinaceae* 1, *Entolomataceae* 1, *Ganodermataceae* 1, *Gloeophyllaceae* 1, *Gomphidiaceae* 1, *Hapalopilaceae* 1, *Hydnangiaceae* 1, *Omphalotaceae* 1, *Paxillaceae* 1, *Pezizaceae* 1, and *Schizophyllaceae* 1.

When compared, the macrofungi of Uşak province were found to have similarities with the findings of studies conducted in other neighbouring regions (Işıloğlu & Watling 1992, Solak et al. 1999, Gezer 2000, Köse et al. 2006). This may have been because of similarities in vegetation, climate and plant flora.

Thirty of the 124 taxa are edible (Phillips 2006), but only *Agaricus bisporus, A. bitorquis, Agrocybe cylindracea, Chroogomphus rutilus, Lactarius deliciosus, L. salmonicolor, Langermannia gigantea, Lepista nuda, Macrolepiota procera, Morchella angusticeps, M. conica, M. distans, M. elata, M. esculenta, Pleurotus eryngii, P. ostreatus, Polyporus squamosus, Rhizopogon luteolus, R. roseolus, Russula delica,* and *Tricholoma myomyces* are known as edible mushrooms by local people. It was also found that the carpophores of *Lactarius deliciosus, Morchella angusticeps, M. conica, M. distans, M. elata, M. esculenta, Pleurotus eryngii,* and *Tricholoma myomyces* were collected and sold by villagers.

About 7% (8 species) of the taxa are poisonous and 68% (86 species) are inedible but none of them are recognised by local people. No poisoning incidents were recorded from the area.

Lignicolous macrofungi represented 21% of the species (27 species) in the area. Some live as parasites on live trees and cause organic product loss and structural damage to the host trees. The most common taxa were *Armillaria, Fomes, Ganoderma, Phellinus, Schizophyllum commune, Stereum,* and *Trametes.*

The following nine taxa are new records for Turkey: *Coprinopsis echinospora, Cystoderma simulatum, Hohenbuehelia semi-infundibuliformis, Hygrophorus capreolarius, Inocybe leucoblema, Leucocoprinus lanzonii, Marasmius chordalis, Mycena renati,* and *Russula rhodopus.*

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Literature cited

Breitenbach J, Kränzlin F. 1984-2000. Fungi of Switzerland. (Vol 1-5). Luzern: Verlag Mykologia.

Brensinsky A, Besl HA. 1990. Colour atlas of poisonous fungi. London: Wolfe Publishing.

CABI Bioscience Databases. 2007. Index Fungorum, http://www.speciesfungorum.org/Names/Names.asp

Capelli A. 1984. Fungi Europaei, Agaricus L.: Fr. Karsten: Libreria editrice Biella Giovanna, Italy.

Ellis B, Ellis JP. 1990. Fungi without gills (Hymenomycetes and Gasteromycetes). London: Chapman and Hill.

Gezer K. 2000. Contribution to the macrofungi flora of Antalya province. Turk J Bot 24: 293-296.

Işıloğlu M, Watling R. 1992. Macromycetes of Mediterranean Turkey. Edinb J Bot 49(1): 99-121.

Köse S, Gezer K, Gökler I, Türkoğlu A. 2006. Macrofungi of Bekilli district (Denizli). Turk J Bot 30: 267-272.

Marchand A. 1971-1986. Champignons du nord et du midi. (1-9). Perpignan: Société Mycologique des Pyrénées Méditerranéennes.

Moser M. 1983. Keys to Agarics and Boleti. Stutgart: Gustav Fischer Verlag.

Pacioni G. (1985). Mushrooms and Toadstools. London: Mac Donald and Co. Ltd.

Phillips R. 1981. Mushrooms and other fungi of Great Britain and Europe. London: Pan Books Ltd.

Phillips R. 2006. Mushrooms. London: Macmillan.

Solak MH, Işıloğlu M, Gücin F, Gökler İ. 1999. Macrofungi of Izmir province. Turk J Bot 23: 383-390.

Solak MH, Işıloğlu M, Kalmış E, Allı H. 2007. Macrofungi of Turkey, Checklist, Volume-I, Bornova-İzmir: Üniversiteliler Ofset.

Watling R. 1982. British fungus flora. *Bolbitiaceae* 3: Agrocybe, Bolbitius Conocybe. 1-139. Edinburgh: Royal Botanic Garden.

Watling R, Gregory NM. 1987. British fungus flora 5: *Strophariaceae* & *Coprinaceae*. Edinburgh: Royal Botanic Garden.

Watling R, Gregory NM. 1989. British fungus flora. Agarics and Boleti 6: *Crepidotaceae, Pleurotaceae* and other pleurotoid Agarics. Edinburgh: Royal Botanic Garden.

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Crepidotus eucalyptinus and *Simocybe haustellaris*: two uncommon species found in Central Spain

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Abstract — *Crepidotus eucalyptinus* and *Simocybe haustellaris* were collected together from a *Quercus ilex* subsp. *ballota* forest in Central Spain (Guadalajara Province). Collections of both species are described and their taxonomically distinctive microscopic characters are illustrated. The superficial similarity between these two brown-spored taxa is discussed as well as the taxonomic status of the former within *Crepidotus* and the close affinity of the species with *Naucoria decolorata* from Morocco and Spain.

Key words — *Crepidotaceae*, taxonomy, wood-inhabiting fungi

Introduction

During field work carried out in two localities with *Quercus ilex* subsp. *ballota* (Desf.) Samp. forest, in the Province of Guadalajara (Central Spain), we found two little, dark-spored agarics inhabiting dead fallen twigs that were identified as members of the *Crepidotaceae* Singer. Although the collections were notably different and distinguishable microscopically as representatives of *Crepidotus eucalyptinus* and *Simocybe haustellaris*, their basidiomes were somewhat superficially similar with regard to their macroscopic variation. We found that compared to other members of the *Crepidotaceae*, these two species are still not well documented with respect to their ranges of morphological variability or detailed comparisons of important taxonomic diagnostic characters, e.g. cortical layers, basidiospores seen under SEM and trama tissues (Bon 1992,

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Breitenbach & Kränzlin 2000, Lonati 1991, Malençon & Bertault 1975, Senn-Irlet 1995a).

Crepidotus eucalyptinus has been taxonomically controversial due to its superficial morphological similarity to *S. haustellaris*: it has occasionally been reduced to a synonym or indirectly linked to other different dark-spored, crepidotoid genera (Bon 1984, Horak 2005, Moreno et al. 2004). *Crepidotus* and *Simocybe*, as revealed by molecular evidence, are the only members of the *Crepidotaceae* that theoretically share in greater or lesser degree a close ancestry (Aime et al. 2005, Moncalvo et al. 2002). In this paper we recognize *C. eucalyptinus* as an isolated taxon in *Crepidotus* having macro- and microscopical features (e.g. small, short-stipitate basidiomes, smooth basidiospores, stipitipellis with cystidiform, terminal hyphae, ungelatinized tissues) that suggests a strong affinity between *Crepidotus* and *Simocybe*. *S. haustellaris* is also described and compared. Additionally, we re-examined material identified as *Naucoria decolorata* (type included), a species known from Morocco and Spain. Based on the similar macro- and micromorphologic characters, we agree (in part) with Horak (2005) in treating *N. decolorata* as conspecific with *C. eucalyptinus*.

Materials and methods

Basidiomes were studied in fresh condition. Color codes in descriptions refer to Kornerup & Wanscher (1967, e.g. 4B2-3) and Munsell color chart (1994, e.g. 10YR 8/3-4). For microscopic observations hand sections of dried samples were mounted in 3% KOH or 1% Congo red. Line drawings were made with the aid of a drawing tube. Measurements were made in KOH, 35-45 spores were measured per collection and the following symbols are used: $\bar{x}$ corresponds to the range of means of length and width of *n* collections, and *Q* corresponds to the range of means of length/width ratio of basidiospores of *n* collections. SEM photographs were obtained after mounting small sections of dry lamellae, these previously rehydrated in NH_4OH, fixed in glutaraldehyde, critically point dried, and later coated with gold-palladium. Herbarium acronyms are according to Holmgren et al. (1990).

Taxonomy

Crepidotus eucalyptinus Maire & Malençon, in Malençon & Bertault, Champ. Sup. du Maroc II: 475, 1975. PLATES 1-4 A-B & 6A-E

≡ *Melanotus eucalyptinus* (Maire & Malençon) E. Horak, Röhrlinge und Blätterpilze in Europa, 508, 2005.

= *Naucoria decolorata* Malençon ex R. Galán, G. Moreno & A. Ortega, in Galán et al., Revista de Biología 12: 62, 1983.

≡ *N. decolorata* Malençon, in Malençon & Bertault, Champ. Sup. du Maroc I: 420, 1970, nom. inval.

≡ *Pleuroflammula decolorata* (Malençon ex R. Galán, G. Moreno & A. Ortega) Bon & G. Moreno, in Bon, Doc. Mycol. 14 (53): 6, 1984.

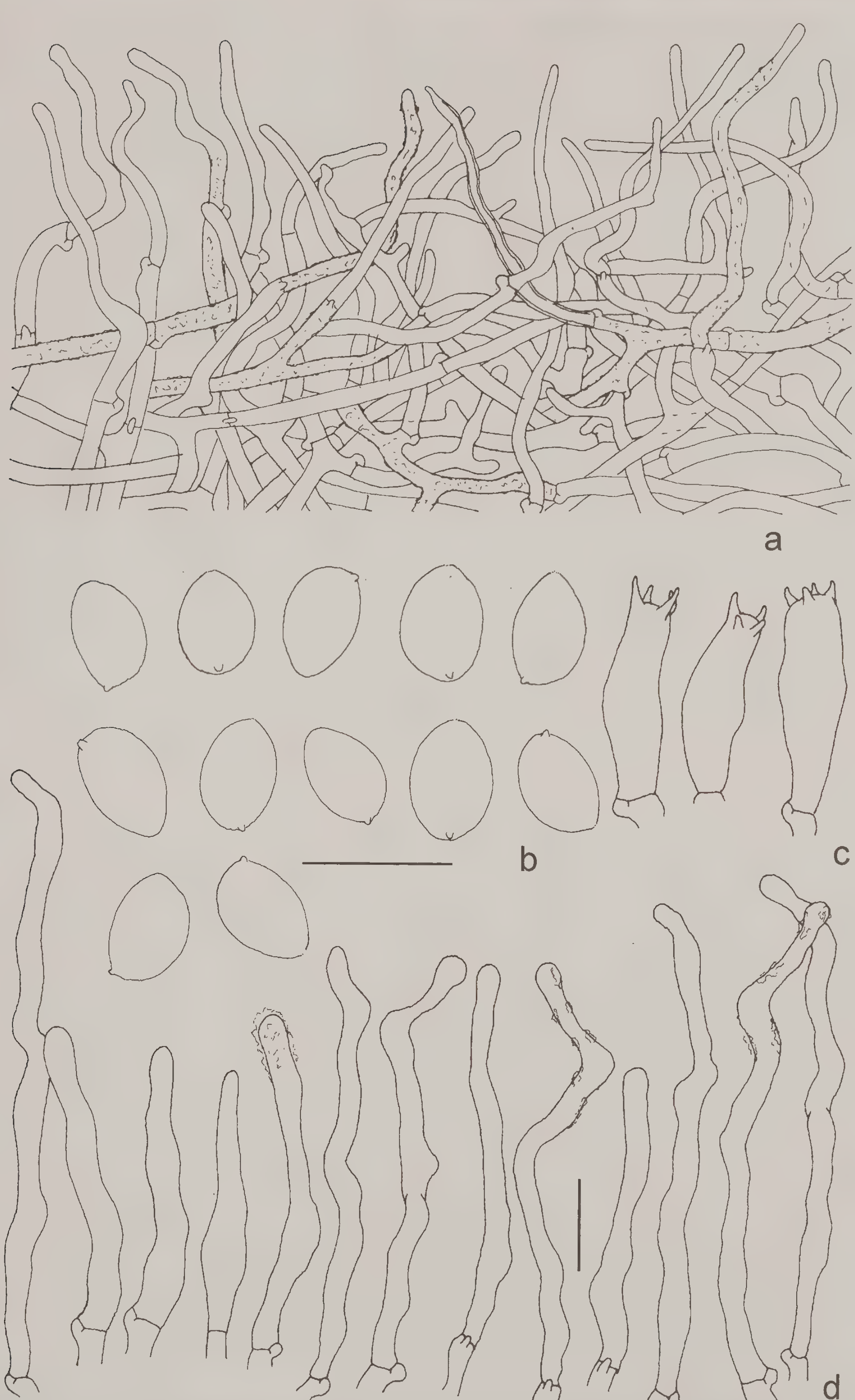

Plate 1. *Crepidotus eucalyptinus*. a. Pileipellis. b. Basidiospores. c. Basidia. d. Cheilocystidia (Bandala 3145). Scale bar = 10 µm, except a = 15 µm.

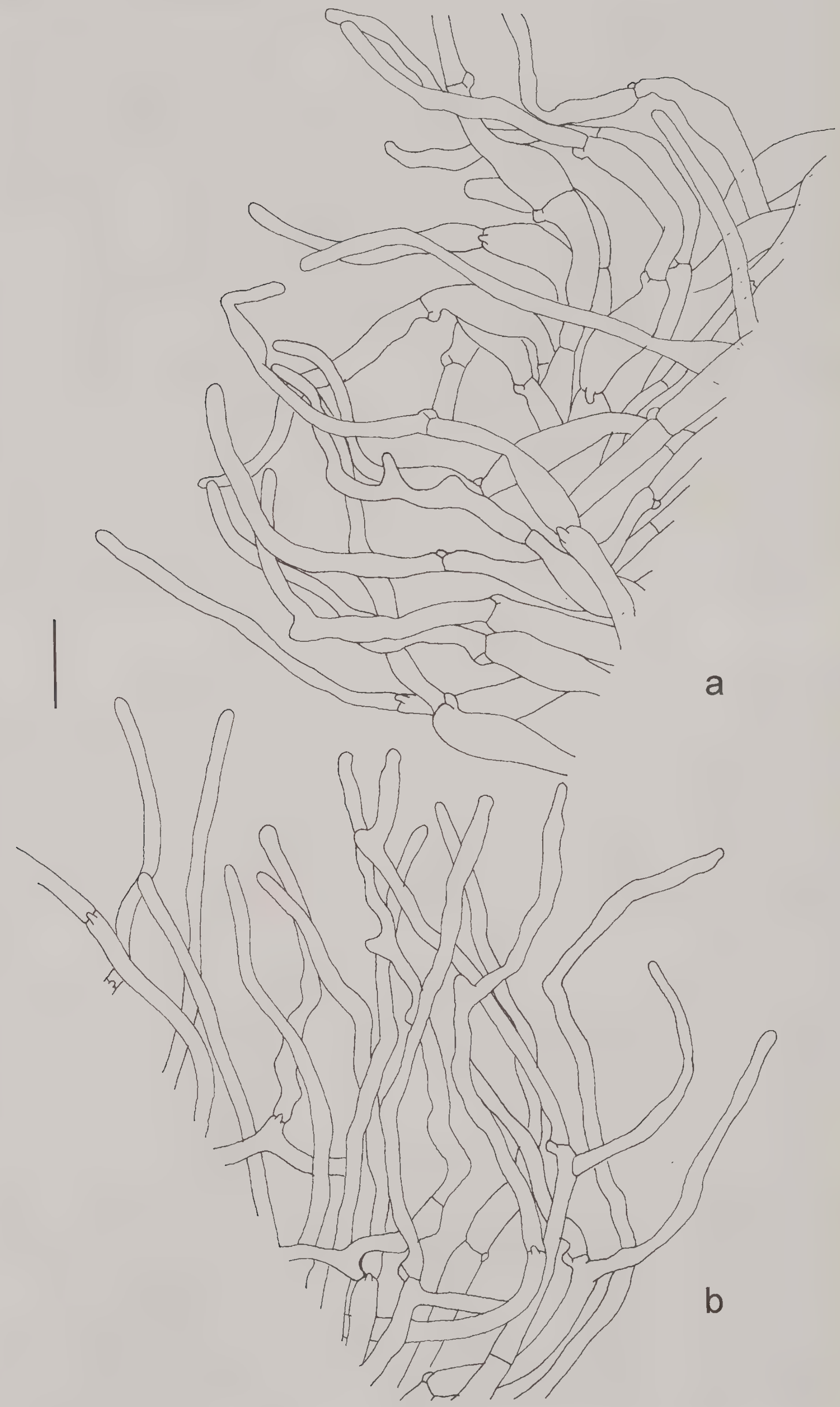

Plate 2. *Crepidotus eucalyptinus*. Stipitipellis. a. near stipe apex. b. near middle portion of stipe (both from same stipe) (Bandala 3145). Scale bar = 15 µm.

Pileus (1–)2–10 mm wide, subglobose in primordial stages, becoming ungulate, campanulate or convex, occasionally plano-convex, free when young, becoming laterally or dorsally attached to substrate, then circular, subcircular, ovate, more or less reniform or rounded flabelliform, whitish to white-grayish (more or less pale 4B2), later pale grayish-yellow (10YR 8/3–4), pale grayish-brown (near 4B2-3) or pale brown (10YR 7/3), dry, weakly hygrophanous, at first fibrillose to somewhat villose, becoming finely tomentose, tomentose-fibrillose or felted-tomentose, gradually glabrescent (seen under magnification); margin incurved, later straight, smooth or weakly striate, occasionally somewhat wavy, then more or less crenate when seen from hymenophore. Lamellae adnate or almost adnate-sinuate, subdistant to distant, moderately broad, subventricose, lamellulae of 3 different lengths; white to whitish, becoming pale grayish-yellow or grayish-cream (more or less dark 3A2; 10YR 8/3–4) to pale yellowish-brown (near 4A3) or grayish yellowish-brown (more or less pale 4B2), edges persistently white and distinctly fimbriate (almost minutely granulose under magnification). Stipe 0.5–1.5(–2) × 0.2–0.5 mm, rudimentary, central and straight in young or primordial stages, becoming eccentric or lateral and curved, often pressed against pileus margin and substrate, subcylindric or tapered towards the base, solid, concolorous with pileus but with a finely fibrillose or fibrillose-tomentose, whitish covering (under magnification). Context white to whitish, thin (<1mm), hygrophanous, unchanging on exposure. Odor none, taste none or slightly astringent.

Basidiospores (6.5–)7–9.5(–10) × (4–)5–6.5 µm, ($\bar{x}$: 7.3–8.6 × 5–5.8; *Q*: 1.33–1.63), ellipsoid to more or less amygdaliform, ovoid to broadly ellipsoid in dorsoventral view, occasionally with a weak depression on the adaxial face but not decidedly reniform, at times bearing a wall discontinuity resembling a germ pore, smooth under immersion lens and SEM (although in this latter some spores appearing very weakly rugulose), without germ pore (but the tip of some spores showing a faintly depressed spot); yellow to pale yellowish-brown, thick-walled (≤ 1 µm thick), inamyloid. Basidia 20–30(–35) × 7–8 µm, clavate, 4-spored, hyaline, thin-walled, clamped. Pleurocystidia absent. Cheilocystidia 25–68 × 2.5–4(–4.5) µm, numerous, subcylindric, narrowly clavate or somewhat elongate and narrowly lageniform, flexuous, at times angled, apex rounded or subcapitate (2–)2.5–4.5(–5) µm wide, occasionally bifurcate, smooth or often irregularly covered with a colorless, resinous material which is variably soluble in KOH, thin- or thick-walled (< 0.5 µm thick), clamped, hyaline. Pileipellis a loose, entangled cutis in transition to a loose trichoderm, composed of filamentous, interwoven hyphae, 2–3(–4) µm wide, bearing a variable number of undifferentiated, flexuous, curved, occasionally coiled, rarely straight terminal elements, in an ungelatinized layer, variable in depth and in density of hyphae, at times even in a single specimen

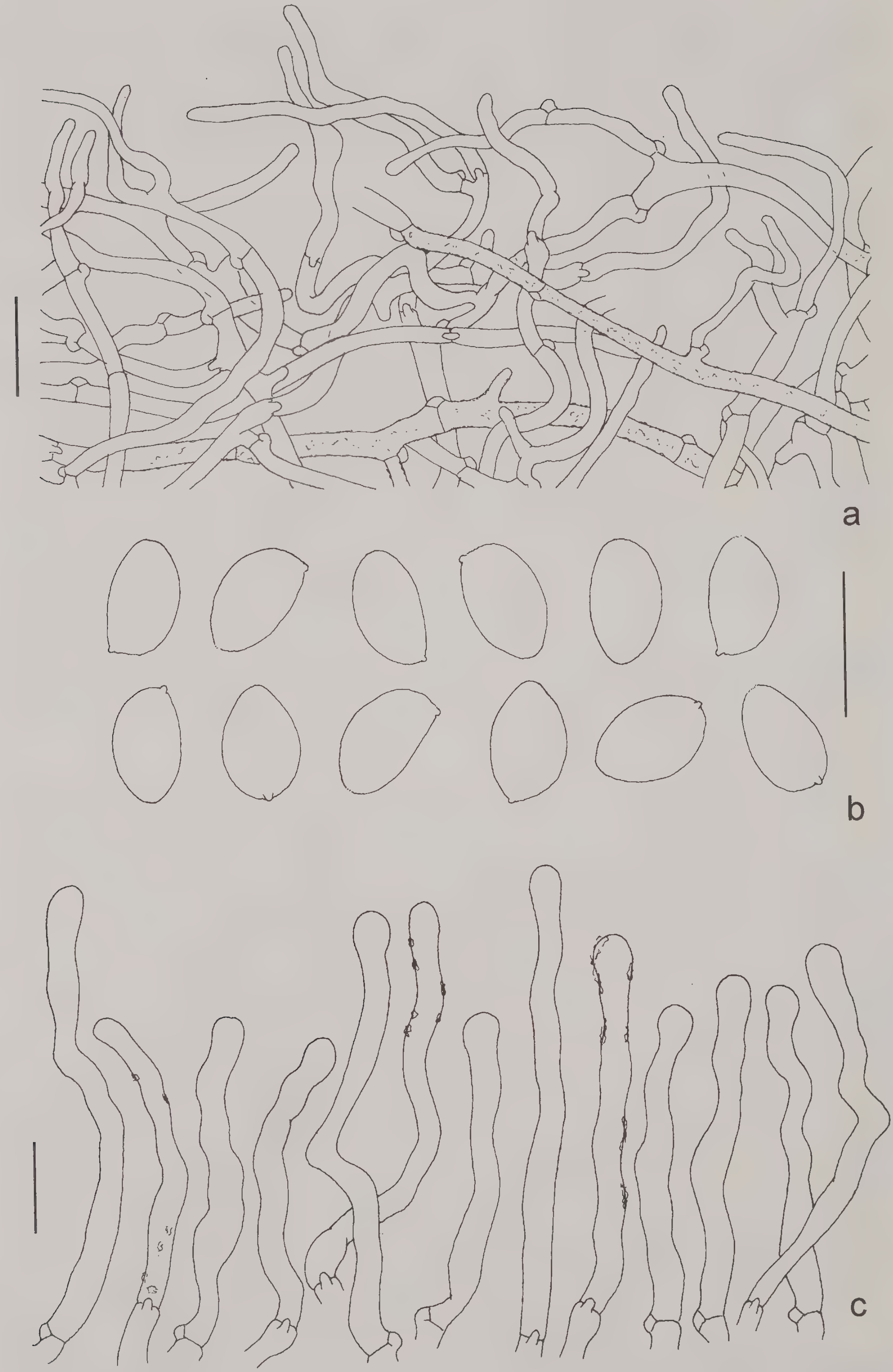

Plate 3. *Crepidotus eucalyptinus*. a. Pileipellis. b. Basidiospores. c. Cheilocystidia (GDAC 8130 as *Naucoria decolorata*). Scale bar = 10 μm, except a = 15 μm.

the superficial hyphae of some areas are more abundant showing a closer arrangement and thus appearing as a loose trichoderm or having a turf-like aspect; hyphae hyaline, pale yellowish or yellowish (then parts of the layer in mass pale yellowish-brown pigmented, but not brown incrusted), simple or bifurcate, sinuous, clamped, thin- or slightly thick-walled (≤ 0.5 µm thick), smooth or part of some segments having colorless, refractive incrustations, also often with scattered, colorless, refractive granules. PILEUS TRAMA with cylindric to somewhat ventricose, interwoven, thin-walled, smooth hyphae, 3–5(–7) µm wide, at times with short lateral projections, hyaline, clamped, ungelatinized. HYMENOPHORAL TRAMA subregular to irregular, with cylindric to somewhat ventricose, thin-walled, smooth hyphae, 3–8 µm wide, hyaline, clamped, ungelatinized. STIPITIPELLIS composed of more or less entangled, loosely or somewhat compactly arranged, cylindric, smooth, hyaline or pale yellowish hyphae, 3–7 (–8) µm wide, bearing undifferentiated (cylindric, elongate) or both elongate and rather narrowly lageniform terminal elements, 3–5 µm wide, at times slightly subcapitate, occasionally forked, sinuous, varying in number and density, then appearing somewhat more packed towards the upper portion near lamellae attachment and having a loose arrangement downwards, then the complete layer recalling the pileipellis structure although thinner in depth, often having scattered, colorless, refractive, minute or coarse granules. STIPE CONTEXT with more or less parallel, hyaline or yellowish (pale yellowish-brown in mass), thin-walled, smooth hyphae. CLAMP CONNECTIONS present in all tissues.

HABITAT. Gregarious, on fallen dead twigs of *Quercus ilex* subsp. *ballota*.

MATERIAL STUDIED — SPAIN. GUADALAJARA: Albalate de Zorita, 7.X.1999, *Bandala 3145;* 15.X.1999, *Bandala 3165, 3166, 3167, 3170, 3171;* 23.XI.2000, *Bandala 3269*; 6.XII.2000, *Bandala 3271, 3275.* Road Cogolludo to Galbe de Sorbe, near Semillas, 30.X.1999, *Bandala 3248* (all at XAL).

OTHER MATERIAL STUDIED — SPAIN. GRANADA: Alhama de Granada, on wood *of Quercus rotundifolia*, 11.XI.1980, *Gil & Galán s.n.* (GDAC 8130, **holotype** of *Naucoria decolorata*). GUADALAJARA: Tamajón, 30.X.2005, *Rejos, Esteve-Raventós & Moreno s.n.* (AH 34371 as *Simocybe haustellaris*). JAÉN: Valdeazores, 17.XI.1989, *Ortega et al. s.n.* (GDAC 31973 as *Naucoria decolorata*); 25.XI.1983, *Ortega s.n.* (GDAC 23717 as *Naucoria decolorata*). MADRID: Colmenarejo, on *Retama*, 2.IV.2004, *Prieto, González & Sastre s.n.* (AH 31148, as *Simocybe haustellaris*); Patones, 16.III.2003, on bark of *Prunus*, *González & Arba s.n.* (AH 31147, as *Simocybe haustellaris*).

COMMENTS — Diagnostic taxonomic features for *Crepidotus eucalyptinus* include basidiospore shape and size, the pileus cuticle structure and cheilocystidial shape and size. Although the holotype from Morocco was unavailable for study we consider the macro- and microscopic features exhibited by all the examined specimens to be identical to those described and illustrated by Malençon & Bertault (1975) for this taxon. Another collection from Morocco having also all the aforementioned key features of *Crepidotus eucalyptinus* is that illustrated and provisionally named as *Naucoria decolorata* by Malençon (in Malençon & Bertault 1970), a taxon validated later by Galán et al. (1983) based on the studied samples at GDAC. In the dried condition, the specimens of *Naucoria decolorata* are macroscopically similar to *Crepidotus eucalyptinus* and we found that basidiospores, pileipellis hyphae, ungelatinized pileus trama and cheilocystidia of the former are also indistinguishable from those showed by the other examined specimens of the latter (Plates 1 & 3). One of the studied samples (*Bandala 3269*) exhibits all the distinctive microscopic features, but its macroscopic aspect is somewhat more robust (recalling *Simocybe haustellaris*) in comparison with the remaining examined specimens. The close affinity between *Crepidotus eucalyptinus* and *Naucoria decolorata* was suggested in fact by Malençon & Bertault (1970: 422). After examining the samples kept at GDAC (Plate 3) we actually support their hypothesis and share the opinion of Horak (2005) who cites *Naucoria decolorata* as a synonym (under *Melanotus eucalyptinus*). G. Malençon found (in Morocco) his collections of *C. eucalyptinus* abundantly scattered on trunks of *Eucalyptus gomphocephala* DC. and (apparently) on *Cytisus* debris, whereas specimens gathered by R. Maire (also in North Africa, Algeria) grew on *E. polyanthemos* Schauer. Material from southern Spain (Granada and Jaén) was recorded inhabiting bark of *Quercus* (Galán et al. 1983). When collecting our samples at Albalate de Zorita we observed many fallen dead twigs of *Quercus* colonized by several basidiomes of *Crepidotus eucalyptinus*. The species has been also reported from Italy (near Roma) inhabiting *Quercus* debris (Lonati 1991, 2000). Present records suggest that *C. eucalyptinus* has apparently a restricted distribution surrounding the Mediterranean area where it seems to occur rarely.

Although this small, whitish to grayish colored taxon has been related with *Pleuroflammula* (Bon 1984), *Simocybe haustellaris* (Moreno et al. 2004) or with *Melanotus* (Horak 2005), we found that even though it is phenotypically similar to members of these genera, *C. eucalyptinus* possesses taxonomically important microscopic features that may actually be linked to *Crepidotus*, i.e. basidiospores virtually ellipsoid (i.e., without a truncate apex and not angular), their color yellow to pale yellowish-brown (consequently the lamellae are pale colored or reaching only grayish yellowish-brown color, not fuscous, blackish or reddish), pileipellis consisting of loosely and radially arranged, filamentous, hyaline (or at least pale) hyphae, bearing undifferentiated terminal cells, pleuro- and pileocystidia absent, and both context and cuticle hyphae ungelatinized, not brown incrusted or brown pigmented and lacking any soluble pigment in KOH. SEM examination of the basidiospores revealed that while most are smooth, some walls do not appear as smooth as when viewed under an oil immersion lens. In such cases the wall irregularity is very subtle (low and fine), reduced to a weakly scabrous-rugulose surface, almost similar (although less evident) to the rugulose pattern of ornamentation found among the members of the *Crepidotellae* Hesler & A.H. Sm. sensu Senn-Irlet (Senn-Irlet 1995b, Senn-Irlet & De Meijer 1998). The apical discontinuity of the wall observed (as a germ pore-like structure) on some spores under immersion lens, appears under SEM as a small, indistinct or faintly depressed (not interrupted) apical area, but the spores do not possess a clear evidence of a true germ pore (Plate 6a-e). Among the smooth-spored *Crepidotus* species reported to have similar characteristics (basidiospores occasionally showing under SEM an indistinct ornamentation and an apical discontinuity of the wall) are *C. mollis* (Schaeff.) Staude and *C. calolepis* (Fr.) P. Karst. (Gonou-Zagou & Delivorias 2005, Pegler & Young 1972, Senn-Irlet 1995b). The stipitipellis is also characteristic, bearing elongate, undifferentiated terminal hyphae, which are loosely arranged and not as a hymeniform-like layer, but in whole resembling the pileipellis design. The refractive, colorless granules, scattered among the entangled hyphae of the pileipellis, as well as the irregular, pale pigmentation of the hyphae in mass, are also notable features of the upper layer of the pileus of *C. eucalyptinus*. Such combination of characters does not seem to indicate taxonomic relationships with other phenotypically similar dark-spored members close to stropharioid or cortinarioid lineages, e.g. *Flammulaster*, *Melanotus*, *Phaeomarasmius* or *Pleuroflammula* (Horak 1980, 2005; Moncalvo et al. 2002, Moser 1983, Singer 1986, Watling & Gregory 1989). Maire and Malençon's species appears to occupy the boundary between *Crepidotus* and *Simocybe*. It is macroscopically intermediate between the group of clamped, ellipsoid-spored species of *Crepidotus*, e.g. *C. albidus* Ellis & Everh., *C. pezizula* (Berk. & Broome) Sacc. and *C. albescens* (Murrill) Redhead, among others (Bandala & Montoya 2000, Pegler 1986, Redhead 1984, Senn-Irlet & De Meijer 1998), and the short-stipitate members of *Simocybe*, e.g. *S. haustellaris* (cf. below), *S. coniophora* (Romagn.) Watling and *S. quebecensis* Redhead & Cauchon (Fournier 2002, Redhead & Cauchon 1989, Senn-Irlet 1995a). The resemblance between *Crepidotus eucalyptinus* with *Simocybe haustellaris* (as *Naucoria haustellaris*) was primarily emphasized by Malençon & Bertault (1975), perhaps because superficially specimens of the former taxon recall *Simocybe* macroscopically and possesses more or less similarly shaped cheilocystidia. If we recognize as differences between *Simocybe* and *Crepidotus*: *i)* the pileipellis with cystidiform terminal elements forming in some cases a hymeniform-like structure (then pileus surface may appear atomate or somewhat velvety under a lens), *ii)* a stipitipellis bearing caulocystidia or at least more defined cystidioid-like terminal elements (then the stipe surface may appear pruinose), *iii)* hyphae of pileus cuticle incrusted or containing brown pigment, and *iv)* rather consistently olivaceous tinged basidiomes (Aime et al. 2005, Bandala et al. 2008,

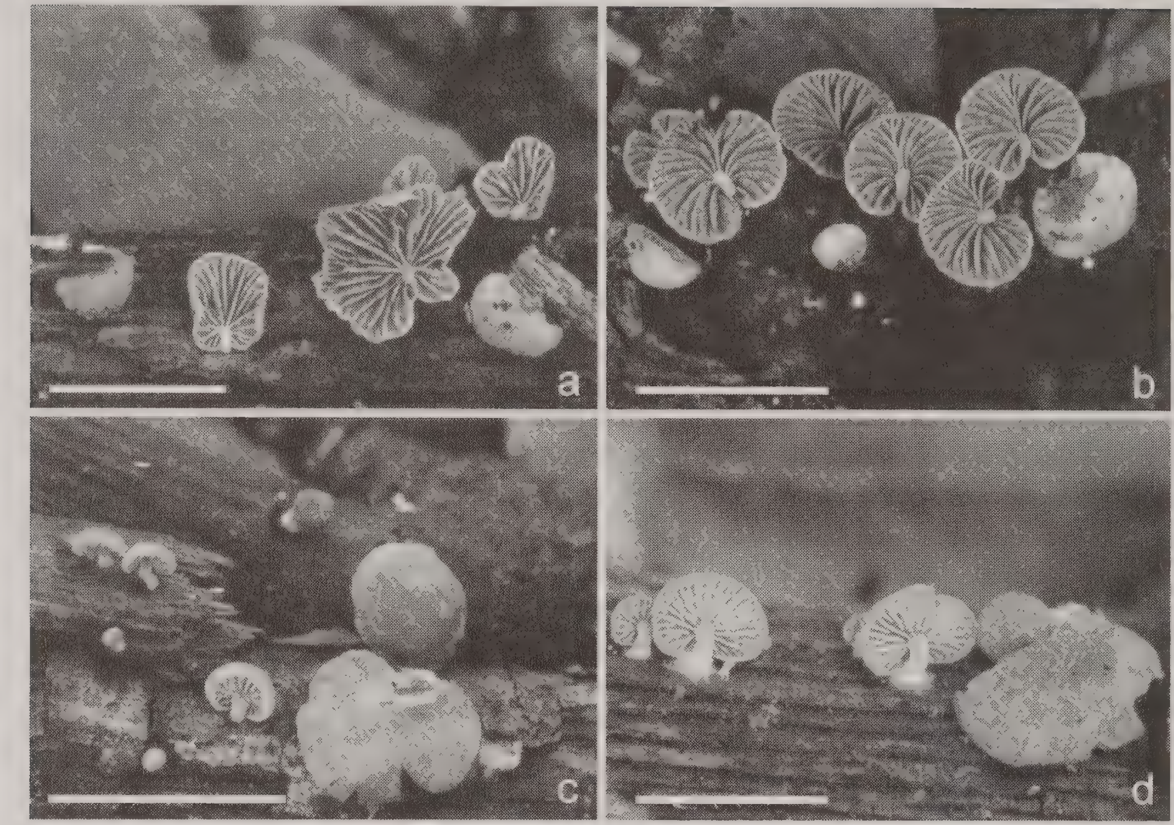

Plate 4. a-b. *Crepidotus eucalyptinus* (a. Bandala. 3165. b. Bandala 3271).
c-d. *Simocybe haustellaris* (Bandala 3172).
Scale bar = 10 mm.

Moser & Jülich 1986, Senn-Irlet 1995a, Singer 1986, Watling & Gregory 1989), then Maire & Malençon's species seems to be reasonably well accommodated within *Crepidotus*. It does, however, reveal the extremely close link between *Crepidotus* and *Simocybe* both genera as discussed by Bandala et al. (2008). After examining some specimens of *S. haustellaris* (see below; cf. Plate 4-6), we found no morphological (either macroscopical or especially microscopical) evidence linking it to *C. eucalyptinus*. Yellowish-brown incrusting pigment, perhaps more indicative of a very close ancestry among these two genera, certainly can be found in some *Crepidotus* species, restricted to the superficial hyphae of pileipellis, that macroscopically form brown fibrils or scales on pileus surface, e.g. *C. calolepis* or *C. crocophyllus* (Berk.) Sacc., among others (Bandala and Montoya 2004, Gonou-Zagou and Delivorias 2005, Hesler and Smith 1965, Senn-Irlet 1995b, Singer 1973). Basidiomes developing grayish colors in age are often observed among the members of *Crepidotus* and a few species are clearly stalked (elongate stipe) (Aime et al. 2002, Bigelow 1980, Horak 1977). The lack of gelatinized tissues particularly separates *C. eucalyptinus* from the reniform-spored species close to Subg. *Crepidotus* sensu Senn-Irlet (1995b), like *C. albescens* or *C. herrerae* Bandala et al. (Bandala et al. 2008, Senn-Irlet & De Meijer 1998). *Crepidotus eucalyptinus* is morphologically different from the rugulose-spored taxa bearing a cutis with filamentous, entangled hyphae and related to the *Crepidotellae* (sensu Senn-Irlet 1995b), either macroscopically or by the size and shape of both basidiospores and cheilocystidia.

Simocybe haustellaris (Fr.) Watling, PLATES 4 C-D, 5 & 6F-I
in Watling & Gregory, Bibl. Mycol. 82: 39, 1981.
≡ *Agaricus haustellaris* Fr., Obs. Mycol. 2: 232, 1818
≡ *Ramicola haustellaris* (Fr.) Watling, N. R. Bot. Gard. Edinb. 45: 556, 1989.
=*Agaricus rubi* Berk., Engl. Flora 5 (2): 102, 1836.
≡ *Simocybe rubi* (Berk.) Singer, Sydowia 15: 72, 1962.
≡ *Ramicola rubi* (Berk.) Watling, N. R. Bot. Gard. Edinb. 45: 555, 1989.
For additional synonyms see: Poumarat et al. (1993), Senn-Irlet (1995a).

PILEUS (2–)3–11 mm wide, subglobose to hemispherical, sometimes conical, becoming convex to plano-convex, free or occasionally laterally attached to substrate, then circular, subcircular or at times more or less ovate or reniform, with greenish or olivaceous tinges (30DE4; 2.5Y 6/4,6/6, 5/4, 5/6) and combining light or dark both brownish-yellow or brownish-orange color (near 5CDE5) or dark grayish-brown tinges, dry, hygrophanous, under lens finely pruinose to somewhat velvety or atomate, at times looking covered with tiny glossy particles (under magnification); margin incurved becoming straight, smooth or weakly striate, occasionally somewhat wavy. LAMELLAE adnate or moderately adnate-sinuate, subdistant, medium broad, more or less ventricose, lamellulae of 3 different lengths; grayish-yellow with greenish tinges (2.5Y 7/4, 7/6, 6/4), edges concolorous or whitish and distinctly fimbriate (almost minutely granulose under magnification). STIPE 2–3 × (approx.) 0.8–1(–1.3) mm, well differentiated, in very young stages central and straight, becoming eccentric, at times lateral, curved (not pressed against pileus margin and substrate), subcylindric, solid, concolorous with pileus but with a pruinose or tomentose-villose, whitish covering. CONTEXT more or less conconcolorous with pileus surface or paler, moderately thick, hygrophanous, unchanging on exposure. Odor and taste none.

BASIDIOSPORES 7–9(–9.5) × (5–)5.5–6.5 µm, ($\bar{x}$: 8.5–8.6 × 5.6–5.8; *Q*: 1.46–1.53), ellipsoid, more or less amygdaliform in lateral view, often faintly depressed adaxially, then more or less reniform, moderately attenuated towards the apex but rounded apically, smooth and without germ pore even under SEM (but seen under immersion lens the wall at times bearing a discontinuity resembling a germ pore), yellowish-brown or pale ochraceous-brown, thick-walled (≤ 1 µm thick), inamyloid. BASIDIA 23–27(–30) × (5–)6–7 µm, clavate to subcylindric, 2-spored, often monosporic, hyaline, thin-walled, clamped. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA (23–)25–47 × (3–)4–6(–7) µm, numerous, subcylindric or moderately narrowly lageniform or narrowly utriform, slightly flexuous, apex rounded, subcapitate 3.5–6 (–6.5) µm wide,

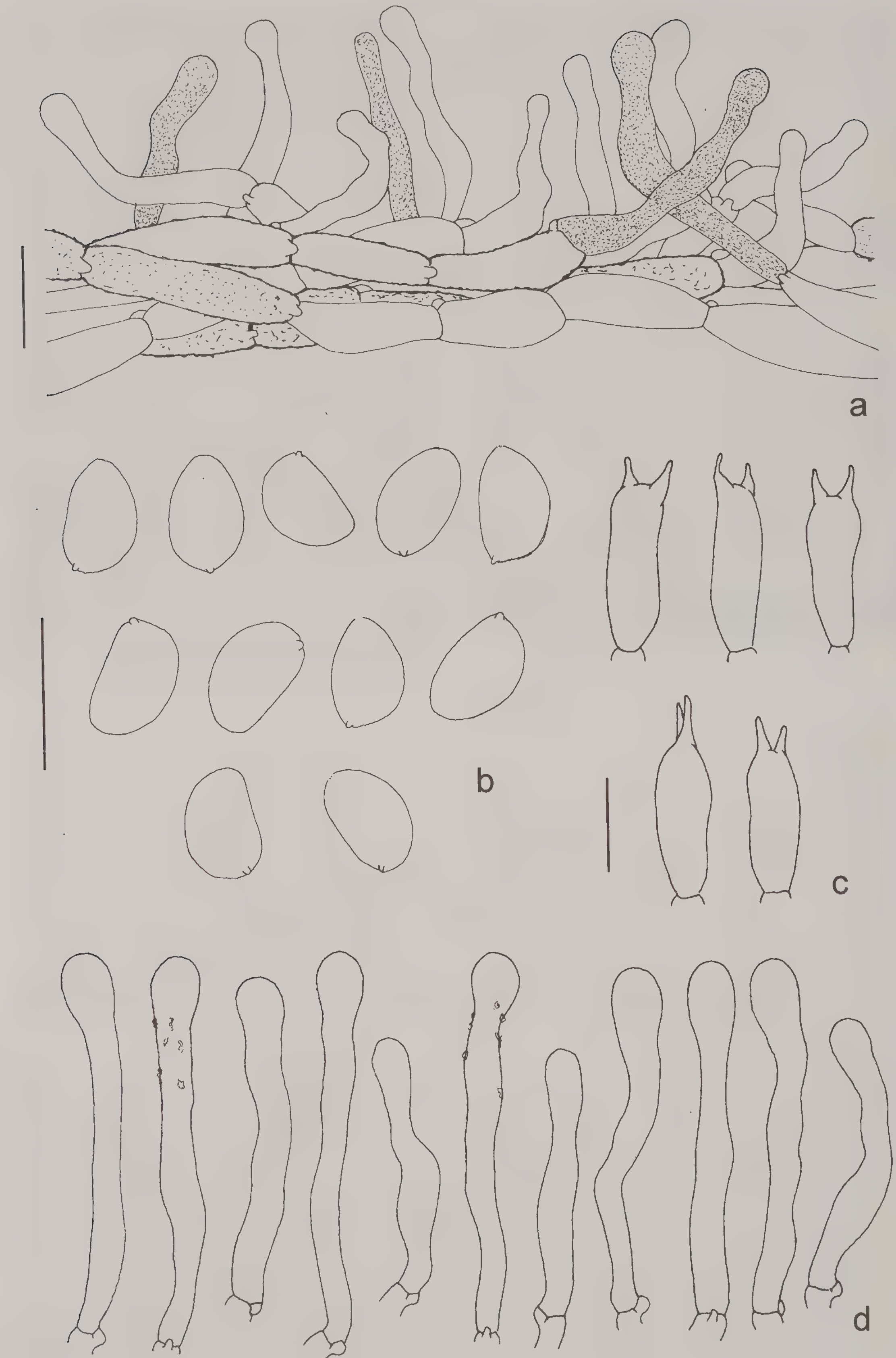

Plate 5. *Simocybe haustellaris*. a. Pileipellis. b. Basidiospores. c. Basidia. d. Cheilocystidia (Bandala 3172). Scale bar = 10 µm, except a = 15 µm.

smooth or often with granular, crystal-like, colorless, scattered incrustations, thin- or thick-walled (< 0.5 μm thick), clamped, hyaline, at times with pale yellowish contents. PILEIPELLIS a cutis of cylindric, compactly interwoven, hyaline or pigmented, brown incrusted hyphae, 4–10 μm wide, with more or less numerous pileocystidia, similar in aspect to cheilocystidia, 20–55(–57) × 3–6(–7) μm, subcapitate (3–7 μm wide), crowded, then in parts recalling a trichodermoid structure, the individual elements pale yellowish, yellow or yellowish-brown, some darker, smooth or incrusted; the layer is ungelatinized and in whole distinctly brown pigmented. PILEUS TRAMA of cylindric to somewhat ventricose, interwoven, thin-walled, smooth, pale yellowish or pale yellowish-brown hyphae, clamped, ungelatinized. HYMENOPHORAL TRAMA subregular, ungelatinized, yellowish, with cylindric to somewhat ventricose, thin-walled, hyaline, clamped hyphae. STIPITIPELLIS with caulocystidia 27–40 × 4–5 μm, subcapitate (3–5 μm wide), similar in aspect to cheilocystidia, in a cutis-like or trichodermoid arrangement, resembling the pileipellis design. STIPE CONTEXT with hyaline or yellowish, brown incrusted hyphae. CLAMP CONNECTIONS present in all tissues.

HABITAT. Subgregarious, on fallen dead twigs of *Quercus ilex* subsp. *ballota*.

> MATERIAL EXAMINED — SPAIN. GUADALAJARA: Albalate de Zorita, 15.X.1999, *Bandala 3172* (XAL).
>
> OTHER MATERIAL EXAMINED — SPAIN. MADRID: El Escorial, on *Rubus* debris, 1.VI.1980, *Lado & Moreno s.n.* (AH 3628-75 as *Simocybe rubi*); Patones, 16.III.2003, on bark of *Prunus*, *González & Arba s.n.* (AH 31147, as *Simocybe haustellaris*).

COMMENTS— *Simocybe haustellaris* and *Crepidotus eucalyptinus* were found in the same locality (Albalate de Zorita) living close together. Some basidiomes of both taxa in the field appeared similar to the naked eye. There are, however, remarkable differences that help distinguish the populations of these two species. Collections of *S. haustellaris* with basidiomes having a relatively reduced stipe and part of the pileus moderately attached to substratum (then showing a more or less crepidotoid aspect) can be distinguished by the comparatively more robust, stout basidiomes bearing a pudgy stipe (Plate 4) and a pileus surface that is variably pruinose-velvety or atomate and exhibits distinctive greenish or olivaceous tinges (these latter are also visible on lamellae and stipe). Anatomical structures that further distinguish *S. haustellaris* and separate it from *Crepidotus* include a cutis with more or less compactly arranged, brown incrusted hyphae bearing cystidiform, pigmented, terminal elements (with the whole layer at times resembling a trichodermoid structure), basidiospores that are ellipsoid and reniform, and a stipitipellis with caulocystidia, which forms a layer similar in aspect to the pileipellis (Plates 5-6). Further, *S. haustellaris* embraces members producing bisporic or tetrasporic basidia and also rather sessile forms (Breitenbach & Kränzlin 2000, Senn-Irlet 1995a). Barely stipitate

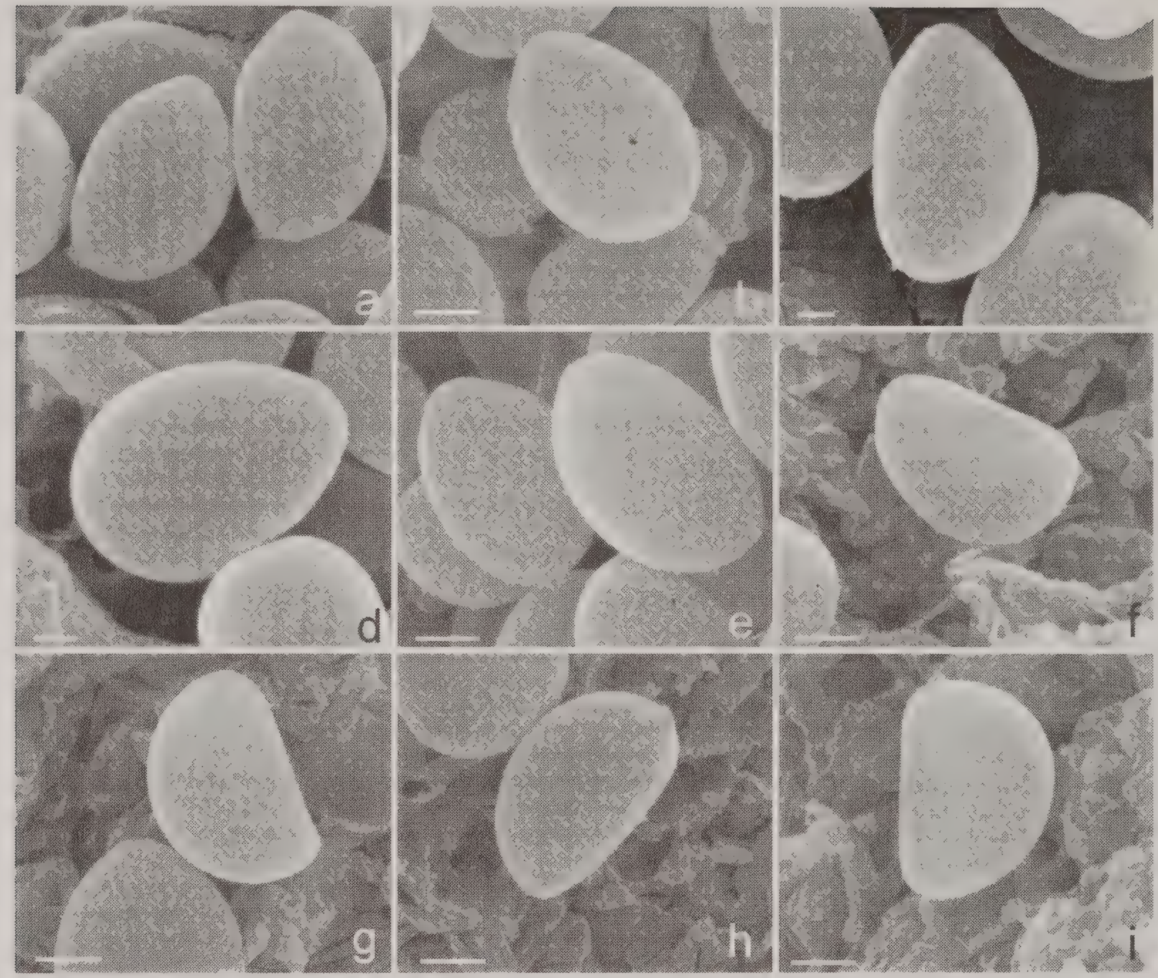

Plate 6. Basidiospores (SEM). **a-e.** *Crepidotus eucalyptinus* (a. Bandala 3145. b. Bandala 3170. c. Bandala 3165. d. Bandala 3145. e. Bandala 3275). **f-i.** *Simocybe haustellaris* (Bandala 3172). Scale bar = 2 µm, except a, c & d = 1 µm.

forms have been interpreted taxonomically different from those having a somewhat more elongate stipe, i.e. as *S. haustellaris* or *S. rubi* respectively (Bon 1992, Moser 1978, Pegler & Young 1975, Watling & Gregory 1989). Two forms for *S. haustellaris* have been proposed by Neville and Poumarat (in Poumarat et al. 1993): f. *haustellaris* embracing crepidotoid forms and f. *rubi* (Berk.) Neville & Poumarat, including those naucorioid forms. As different degrees of stipe elongation can be observed even among the elements of a same collection, we share the opinion that it reveals part of the variation of a single taxon more than distinguishing taxonomic entities (Breitenbach & Kränzlin 2000, Døssing 1992, Horak 2005, Reid 1984, Romagnesi 1962, Senn-Irlet 1995a). Among the species of *Simocybe*, *S. haustellaris* differs by the following combination of features: relatively small basidiomes with eccentric, short stipe, pileipellis a cutis composed of cylindric hyphae bearing cystidiform terminal elements and the size and shape of the basidiospores.

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Literature cited

Aime MC, Baroni TJ, Miller OK. 2002. *Crepidotus thermophilus* comb. nov., a reassessment of *Melanomphalia thermophila*, a rarely collected tropical agaric. Mycologia 94: 1059-1065.

Aime MC, Vilgalys R, Miller OK. 2005. The *Crepidotaceae* (*Basidiomycota, Agaricales*): phylogeny and taxonomy of the genera and revision of the family based on molecular evidence. American Journal of Botany 92: 74-82.

Bandala VM, Montoya L. 2000. A taxonomic revision of some American *Crepidotus*. Mycologia 92: 341-353.

Bandala VM, Montoya L. 2004. *Crepidotus* from Mexico: new records and type studies. Mycotaxon 89: 1-31.

Bandala VM, Montoya L, Mata M. 2008. New species and new records of *Crepidotus* from Costa Rica and Mexico. Fungal Diversity (in press).

Bigelow HE. 1980. *Crepidotus nyssicola*. Mycologia 72: 1227-1231.

Bon M. 1984. Combinaisons et taxons nouveaux. Doc. Mycol. 14 (53): 57.

Bon M. 1992. Clé monographique des espéces galero-naucorioides. Doc. Mycol. 21 (84): 1-89.

Breitenbach J, Kränzlin F. 2000. Fungi of Switzerland. Vol 5. Verlag Mykologia, Luzern, Switzerland, 338 p.

Døssing L. 1992. *Ramicola* Vel. (*Simocybe* Karst. ss. auct.). In: Hansen L, Knudsen H. eds. Nordic macromycetes II. Polyporales, Boletales, Agaricales, Russulales. 339-340. Nordsvamp, Copenhagen.

Fournier J. 2002. Un *Simocybe* peu commun: *S. coniophora* (Romagn.) Watl. 1981 découvert dans les Pyrénées centrals. Doc. Mycol. 31 (124): 15-17.

Galán R, Ortega A, Moreno G. 1983. Sobre *Naucoria decolorata* G. Malençon (Agaricales). Revista de Biología 12: 61-64.

Gonou-Zagou Z, Delivorias P. 2005. Studies on Basidiomycetes in Greece 1: The genus *Crepidotus*. Mycotaxon 94: 15-42.

Hesler LR, Smith AH. 1965. North American species of *Crepidotus*. New York: Hafner Publ. 168 p., 33 figs.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part I. The Herbaria of the world. 8th edn. New York. 693p.

Horak E. 1977. *Crepidotus episphaeria* and related species from the Southern Hemisphere. Ber. Schweiz. Bot. Ges. 87: 227-235.

Horak E. 1980. Fungi Agaricini Novazelandiae VIII. *Phaeomarasmius* Scherffel and *Flammulaster* Earle. N. Z. J. Bot. 18: 173-182.

Horak E. 2005. Röhrlinge und Blatterpilze in Europa. Elsevier, Spektrum Akademischer Verlag. 555 p.

Kornerup A, Wanscher JH. 1967. Methuen handbook of colour. 2th ed., Methuen, London.

Lonati G. 1991. Due funghi rari o poco conosciuti: *Crepidotus eucalyptinus* e *Clitopilus honsonii*. Micol. Veg. Medit. 6: 33--38.

Lonati G. 2000. Il genere *Crepidotus* in area Mediterranea. Micol. Veg. Medit. 15: 161-186.

Malençon G, Bertault R. 1970. Champignons supérieurs du Maroc I. Inst. Cient. Cherifien-Faculté des Sciences de Rabat, Rabat.

Malençon G, Bertault R. 1975. Champignons supérieurs du Maroc II. Inst. Cient. Cherifien-Faculté des Sciences de Rabat, Rabat.

Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Clémençon H, Miller OK. 2002. One hundred and seventeen clades of euagarics. Mol. Phylogen. & Evol. 23: 357-400.

Moreno G, Prieto-García F, González A. 2004. Adiciones al catálogo micológico de la zona centro peninsular II. Bol. Soc. Micol. Madrid 28: 207-219.

Moser M. 1978. Fungorum rariorum icones coloratae VII. J. Cramer, Vaduz

Moser M. 1983. Key to agarics and boleti (*Polyporales, Boletales, Agaricales, Russulales*). Roger Phillips, London.

Moser M, Jülich W. 1986. Farbatlas der Basidiomyceten III. Stuttgart: Gustav Fischer.

Munsell and soil color charts. 1994. Macbeth, New Windsor.

Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bull. Add. Ser. XII, HMSO, London.

Pegler DN, Young TWK. 1972. Basidiospore form in the British species of *Crepidotus*. Kew Bull. 27: 311–323.

Pegler DN, Young TWK. 1975. Basidiospore form in the British species of *Naucoria*, *Simocybe* and *Phaeogalera*. Kew Bull. 30: 225-240.

Poumarat S, Fouchier F, Neville P. 1993. Un taxon de délimitation spécifique et d'affectation générique controversées : *Ramicola haustellaris* (Fr. :Fr.) Watl. Bull. Fedér. Assoc. Mycol. Medit. 3 : 26-34 + 1pl.

Redhead SA. 1984. Mycological observations, 4-12: on *Kuehneromyces, Stropharia, Marasmius, Mycena, Geopetalum, Omphalopsis, Phaeomarasmius, Naucoria* and *Prunulus*. Sydowia 37: 246-270.

Redhead SA, Cauchon R. 1989. A new species of *Simocybe* from Canada. Sydowia 41: 292-295.

Reid DA. 1984. A revision of the British species of *Naucoria* sensu lato. Trans. Br. Mycol. Soc. 82: 191-237.

Romagnesi H. 1962. Les *Naucoria* du groupe *centunculus* (*Ramicola* Velen.). Bull. Soc. Mycol. Fr. 78: 337-358.

Senn-Irlet B. 1995a. Die gattung *Simocybe* Karsten in Europa. Mycol. Helvetica 7: 27-61.

Senn-Irlet B. 1995b. The genus *Crepidotus* (Fr.) Staude in Europe. Persoonia 16: 1-80.

Senn-Irlet B, De Meijer A. 1998. The genus *Crepidotus* from the state of Paraná, Brazil. Mycotaxon 66: 165-199.

Singer R. 1973. The genera *Marasmiellus, Crepidotus* and *Simocybe* in the neotropics. Beih. Nova Hedwigia 44: 1-484.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4th Ed. Koeltz Sc. Books, Koenigstein.

Watling R, Gregory NM. 1989. *Crepidotaceae, Pleurotaceae* and other pleurotoid agarics. British Fungus Flora 6: 1-157.

MYCOTAXON

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Black mildew disease of the neotropical orchid *Epidendrum secundum* caused by *Lembosia epidendri* sp. nov. from Minas Gerais, Brazil

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Abstract — A new black mildew disease was observed on the orchid species *Epidendrum secundum* in the "campos rupestres" of Carrancas, Minas Gerais State, Brazil. *Lembosia epidendri* sp. nov., the causal agent of the new disease is described, illustrated and compared with three allied *Lembosia* species on the family *Orchidaceae*.

Key words — *Ascomycetes*, *Asterinaceae*, biodiversity, foliicolous fungi, phytopathology, tropical fungi

Introduction

Epidendrum secundum Jacq. is a orchid species with epiphytical or terrestrial habitat, characteristic of the Brazilian "high elevation grasslands" and the Brazilian "campos rupestres" (Caiafa & Silva 2005, Neto et al. 2007). In June 2006 an exploratory project of surveying and describing the phytopathogenic and endophytic mycodiversity associated with the family *Orchidaceae* in the state of Minas Gerais was started. During a botanical survey in the "campos rupestres" of Carrancas city in Minas Gerais State, Brazil, samples of the orchid *E. secundum* with a black mildew disease symptoms were collected. The fungus on *E. secundum* proved to be a new species of the genus *Lembosia*, which is described, illustrated and discussed in this paper.

Material and methods

Samples of infected parts of *E. secundum* were collected, photographed (SONY DSC-H9 digital camera), dried in a plant press and deposited at VIC Herbarium. Selected small samples of the fungus were removed from fresh leaf spots and mounted in lactophenol. Observations, measurements and illustrations were carried out by means of an OLYMPUS BX 50 light microscope fitted with a digital camera (EVOLT E330) and a drawing tube. Wherever possible, 30 measurements were made of the structures mounted.

Taxonomic description

Lembosia epidendri Meiriele Silva & O.L. Pereira, **sp. nov.** **FIGS. 1–3**

MycoBank 511465

Mycelia superficialia ex hyphae brunneae, septatae, usque 3 μm latae, hyphopodiatae. Hyphopodia aseptata, brunnea, lateralis, globosa, laeves, usque 6–9.5 μm lata. Hysterothecia 319–577 μm longa, 135–245.5 μm lata, plerumque lineares, raro Y-forma, epigena, aliquando coalescentes, nigra, dispersa, fissurum ostiole pariete exioliore longitudinali aperientis. Paraphysoids filiformes, numerosae, septatae, hyalinae, ramosae. Asci saccati vel ovati, bitunicati, octospori, sessilis vel brevipedicellati 28–63 × 16–25 μm. Ascosporae fusiformes, uniseptatae, constrictae, hyalinae, brunneae ad maturitam, 16–22 × 6–9.5 μm.

Etymology: referring to the host genus *Epidendrum*

Holotype: BRAZIL, Minas Gerais, Carrancas, on leaves of *Epidendrum secundum*, 10 Dec. 2007, O. L. Pereira (VIC 30554). **Paratype:** BRAZIL, Minas Gerais, Carrancas, on leaf sheath of *Epidendrum secundum*, 10 Dec. 2007, O. L. Pereira (VIC 30557).

Mycelia superficial composed of brown, septate, branched, up to 3 μm hyphopodiate hyphae. Hyphopodia (appressoria) aseptate, brown, lateral, globose, smooth, 6–9.5 μm wide. Hysterothecia 319–577 μm long, 135–245.5 μm wide, mostly linear, rarely Y-shaped, epigenous, closely grouped together, sometimes fusing with each other, black, superficial, opening by a longitudinal slit. Paraphyses numerous, filiform, septate, hyaline, branched, becoming slimy with age. Asci saccate to ovoid, bitunicate, 8-spored, sessile to short-stalked, 28–63 × 16–25 μm, parallel on the basal layer of the hysterothecia. Ascospores fusiform, 1-septate in the middle, constricted, hyaline, becoming brown at maturity, 16–22 × 6–9.5 μm.

Comments — The asterinaceous fungus found on *E. secundum* clearly belongs to the genus *Lembosia* in having a linear or Y-shaped hysterothecium, opening by a longitudinal slit, adhered to the host epidermis by superficially branched hyphae with hyphopodia (appressoria) (Hosagoudar et al. 2001, Bezerra 2004). The biotrophic nature of *Lembosia*, as in other asterinaceous genera, means that host specificity has played a major role in the species definition (Müller & Arx 1962). Only three *Lembosia* species were known to occur on a member of the family *Orchidaceae* (Dennis 1970, Horne 1905, Song & Hosagoudar 2003) viz. *Lembosia rolfsii* W.T. Horne reported on *Vanilla planifolia* Andrews in USA and *Vanilla wrightii* Rchb. f. in Dominican Republic, *Lembosia sertiferae* Syd. reported on *Sertifera purpurea* Lindl. & Rchb. f. in Ecuador and *Lembosia dendrochili* Lév. reported on *Dendrochilum aurantiacum* Blume in Java.

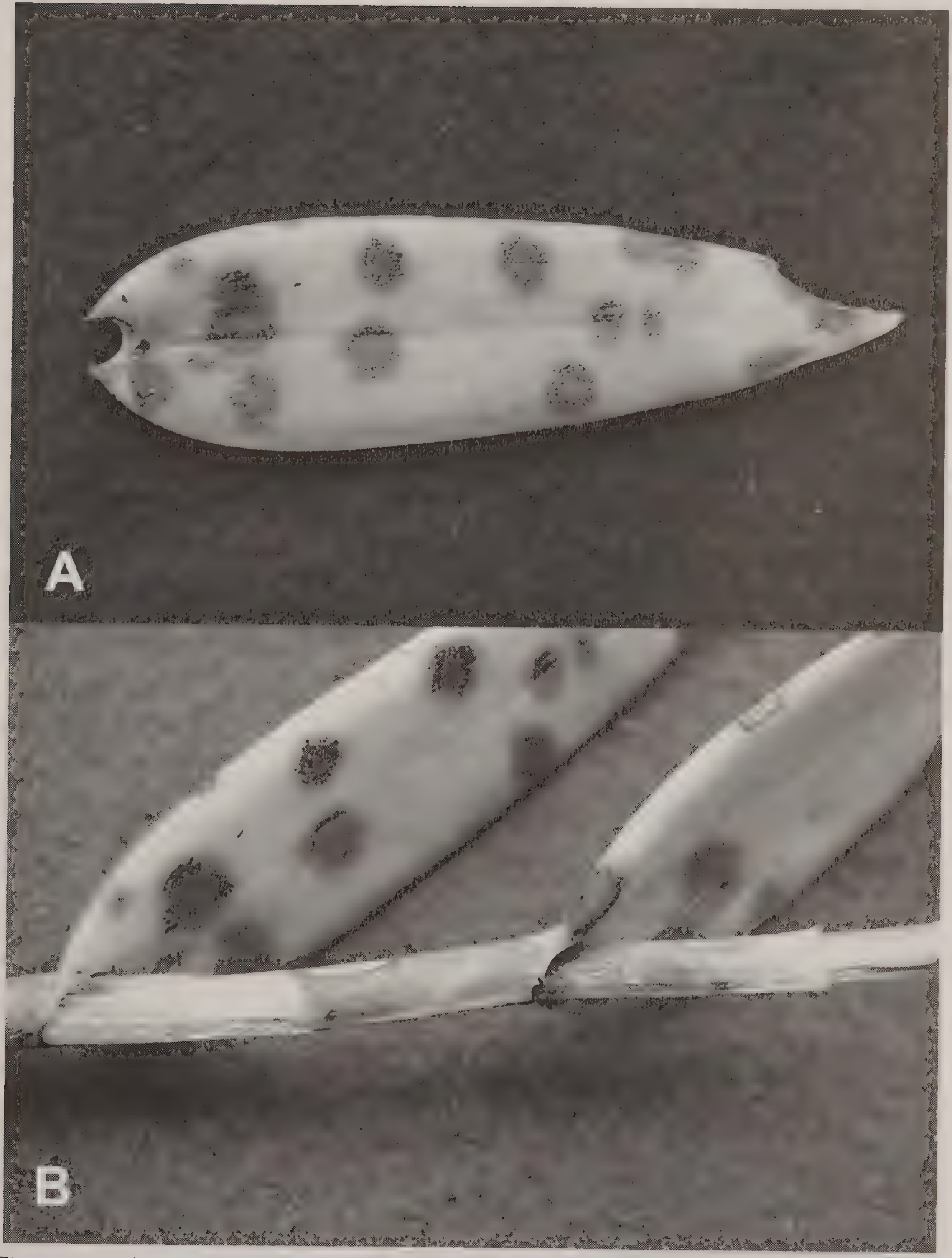

Figure 1. *Lembosia epidendri*. Symptoms of black mildew disease on (A) adaxial leaf surface (VIC 30554, holotype) and on the (B) leaf sheath (VIC 30557) of *Epidendrum secundum*.

Lembosia rolfsii, *L. sertiferae* and *L. dendrochili* produces 10–16 × 4–5 μm, 16–18 × 6–7 μm and 14–16 x 6–7 μm ascospores respectively. *Lembosia epidendri* clearly differs from these other *Lembosia* species on the family *Orchidaceae* in having longer (16–22 μm) and wider (6–9.5 μm) ascospores and the only

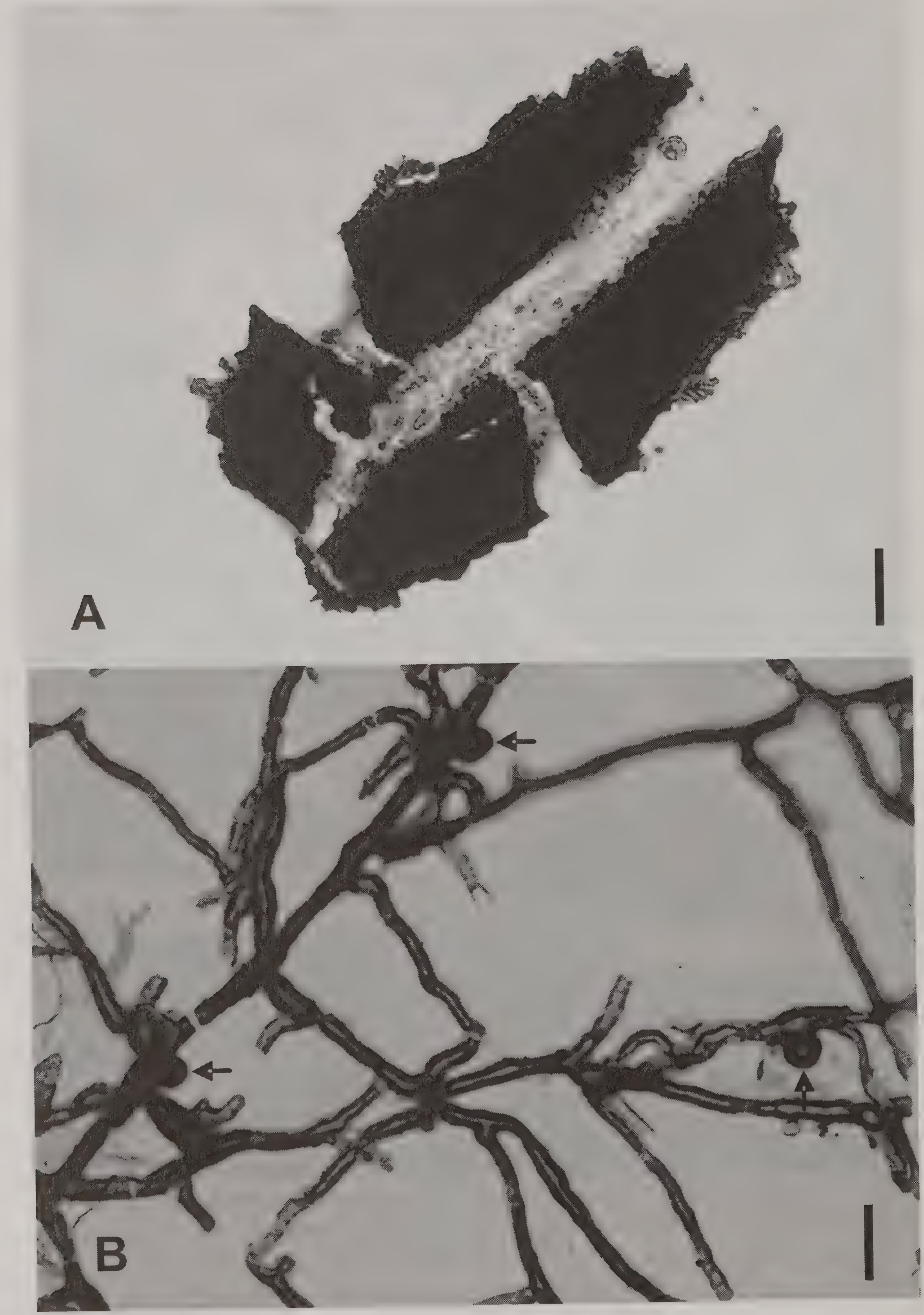

Figure 2. *Lembosia epidendri* (VIC 30554, holotype). (A) Black hysterothecium opening by a longitudinal slit. Scale bar: 50 µm. (B) External mycelia with hyphopodia (arrowheads). Scale bar: 10 µm (B).

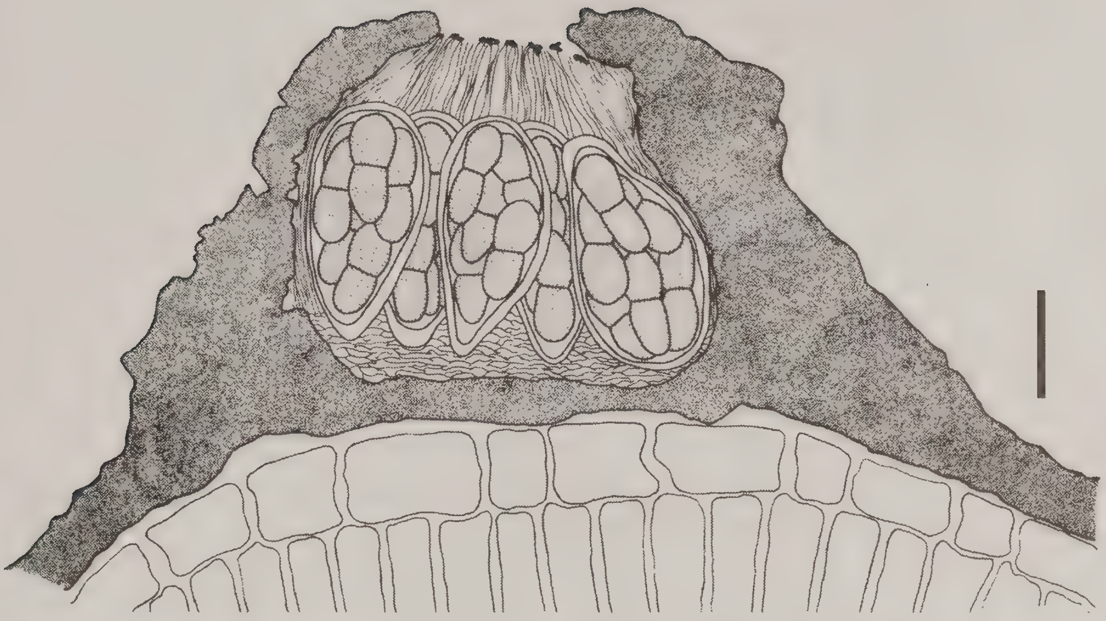

Figure 3. *Lembosia epidendri* (VIC 30554, holotype). Vertical section of hysterothecium showing asci with ascospores. Scale bar: 10 µm.

described on the genus *Epidendrum*. Hence, the introduction of a new species seems to be justified.

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Literature cited

Bezerra JL. 2004. Taxonomia de ascomicetos: revisão da ordem *Asterinales*. Revisão Anual de Patologia de Plantas 12: 91-115.

Caiafa NA, Silva AF. 2005. Composição florística e espectro biológico de um campo de altitude no Parque Estadual da Serra do Brigadeiro, Minas Gerais – Brazil. Rodriguésia 56: 163-173.

Dennis RWG. 1970. Kew Bulletin Additional Series III. Fungus flora of Venezuela and adjacent countries. Kew, Verlag von J. Cramer.

Horne WT. 1905. A new species of *Lembosia*. Bulletin of the Torrey Botanical Club 32: 69-71.

Hosagoudar VB, Abraham TK, Biju CK. 2001. Re-evaluation of the family *Asterinaceae*. Journal of Mycopathological Research 39: 61-63.

Müller E, Arx JA von. 1962. Die Gattungen der didymosporen Pyrenomyceten. Beiträge zur Kryptogamenflora der Schweiz 11: 1-922.

Neto LM, Alves RJV, Barros F, Forzza RC. 2007. *Orchidaceae* do Parque Estadual de Ibitipoca, MG, Brasil. Acta Botanica Brasilica 21: 687-696.

Song B, Hosagoudar VB. 2003. A list of *Lembosia* species based on the literature. Guizhou Science 21: 93-101.

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A new inoperculate discomycete with compound fruitbodies

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Abstract — A cup-fungus on a twig of a broadleaf tree from Tuomer Peak of Xinjiang, China was examined. The combination of aggregated apothecia forming a hemispherical to golf ball-like structure, ectal excipular tissues with hyaline hyphae embedded in a gel matrix, medullary excipular tissues not gelatinized and with brown, granulate, interwoven hyphae, presence of crystals in excipular tissues, subcylindrical asci with a thickened and truncate, inamyloid apex, and allantoid ascospores makes it new in the inoperculate cup-fungi. A new monotypic genus *Sinofavus* is proposed.

Keywords — *Sinofavus allantosporus*, taxonomy

Introduction

On a collecting trip by the junior author to Tuomer Peak of Xinjiang in northwestern China, an interesting fungus was encountered. When young the fruitbodies appeared as a coarse network erumpent from bark of a broadleaf tree. At maturity, up to 50 apothecia are densely and tightly aggregated into a tiny, brown, honeycomb-like structure (compound fruitbody) and with the apothecial margins paler. Individual apothecia are deep-cupulate (Fig. 1). Excipular surface is visible only at the outermost surface of the compound fruitbody.

Materials and methods

An apothecium at margin of the dried compound fruitbody was rehydrated and sectioned at a thickness of 15–20 μm with a freezing microtome (YD-

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1508A, Yidi Medical Instrument Co.). Measurements were taken from the sections and from squash mounts in cotton blue-lactophenol solution. Ascus iodine reaction was tested in Melzer's reagent without KOH pretreatment. Ionomidotic reaction of apothecial tissue was tested in aqueous 3% KOH solution. Photographs were taken with a digital camera (Canon G5) connected with a microscope (Zeiss Axioskop 2 plus). The collection studied is on deposit in the Herbarium of Mycology, Jilin Agricultural University (HMJAU) and the Herbarium of Mycology, Chinese Academy of Sciences (HMAS).

Taxonomy

Sinofavus W.Y. Zhuang, **gen. nov.**

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Apotheciis aggregatis, cupulatis; excipulis externis in gelatino inclusis, cum textura intricata; excipulis medullosis nongelatinosis; ascis inoperculatis, ex uncis oriundis, J–, 8-sporis; ascosporis unicellularibus, hyalinis.

Etymology: Generic name refers to locality and honeycomb-like compound fruitbodies of the fungus.

Apothecia gregarious, forming compound, honeycomb-like fruitbodies; ectal excipulum of textura intricata, in gel matrix; medullary of textura intricata, tissues not gelatinized; asci inoperculate, 8-spored, with apex thickened and somewhat truncate, inamyloid, arising from croziers; ascospores unicellular, hyaline.

Type species: *Sinofavus allantosporus*.

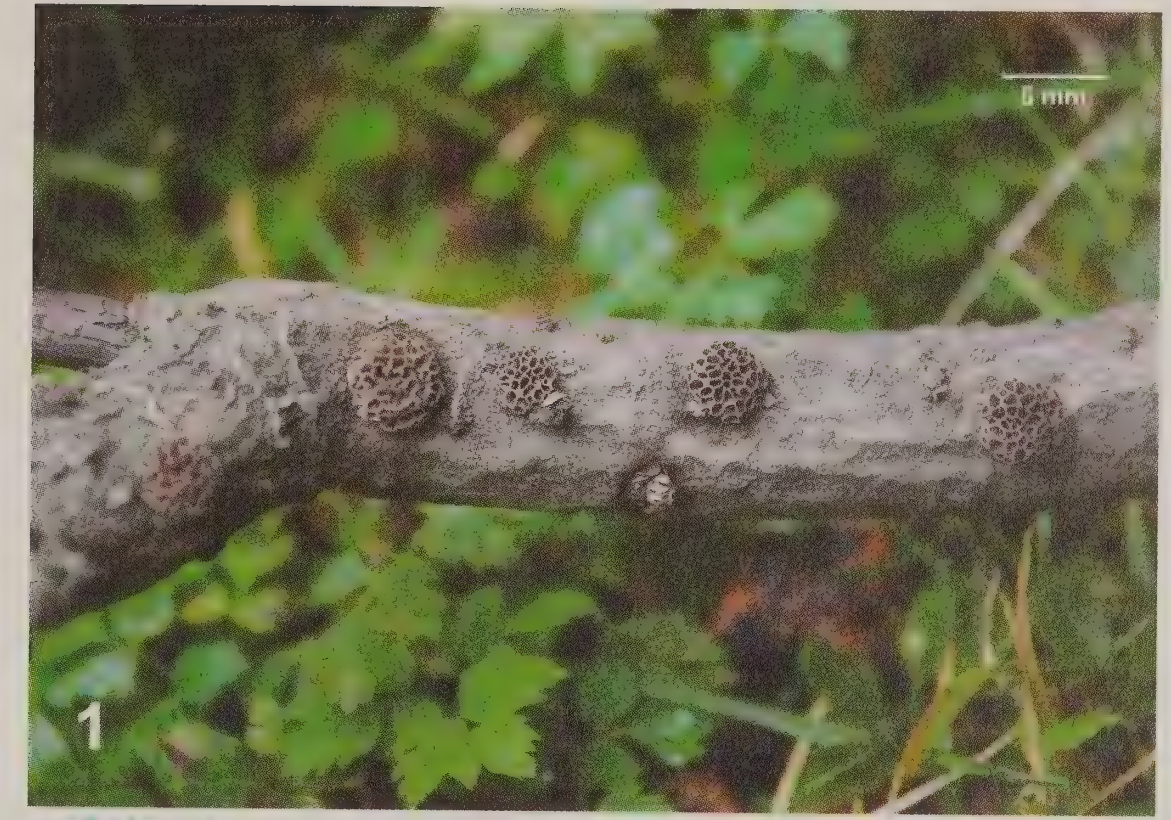
Sinofavus allantosporus W.Y. Zhuang & Tolgor, **sp. nov.** Figs. 1–5

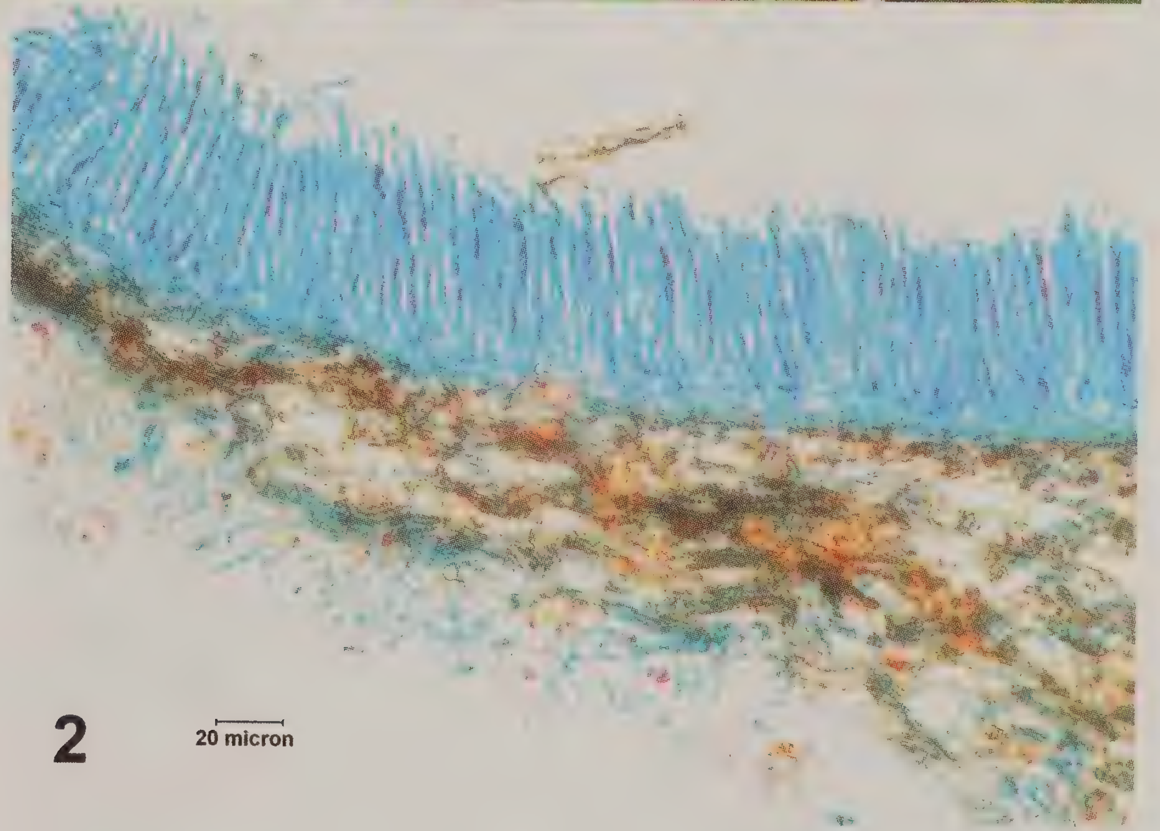
MycoBank MB 511661

Apotheciis cupulatis, stricte aggregatis; excipulis extalibus in gelatino, cum textura intricata; excipulis medullosis nongelatinosis, cum textura intricata; ascis 8-sporis, subcylindricis, 50–67 × 5–6 µm; ascosporis unicellularibus, allantoideis, hyalinis, nonguttulatis, 7.5–10 × 1. 5–1.8 µm.

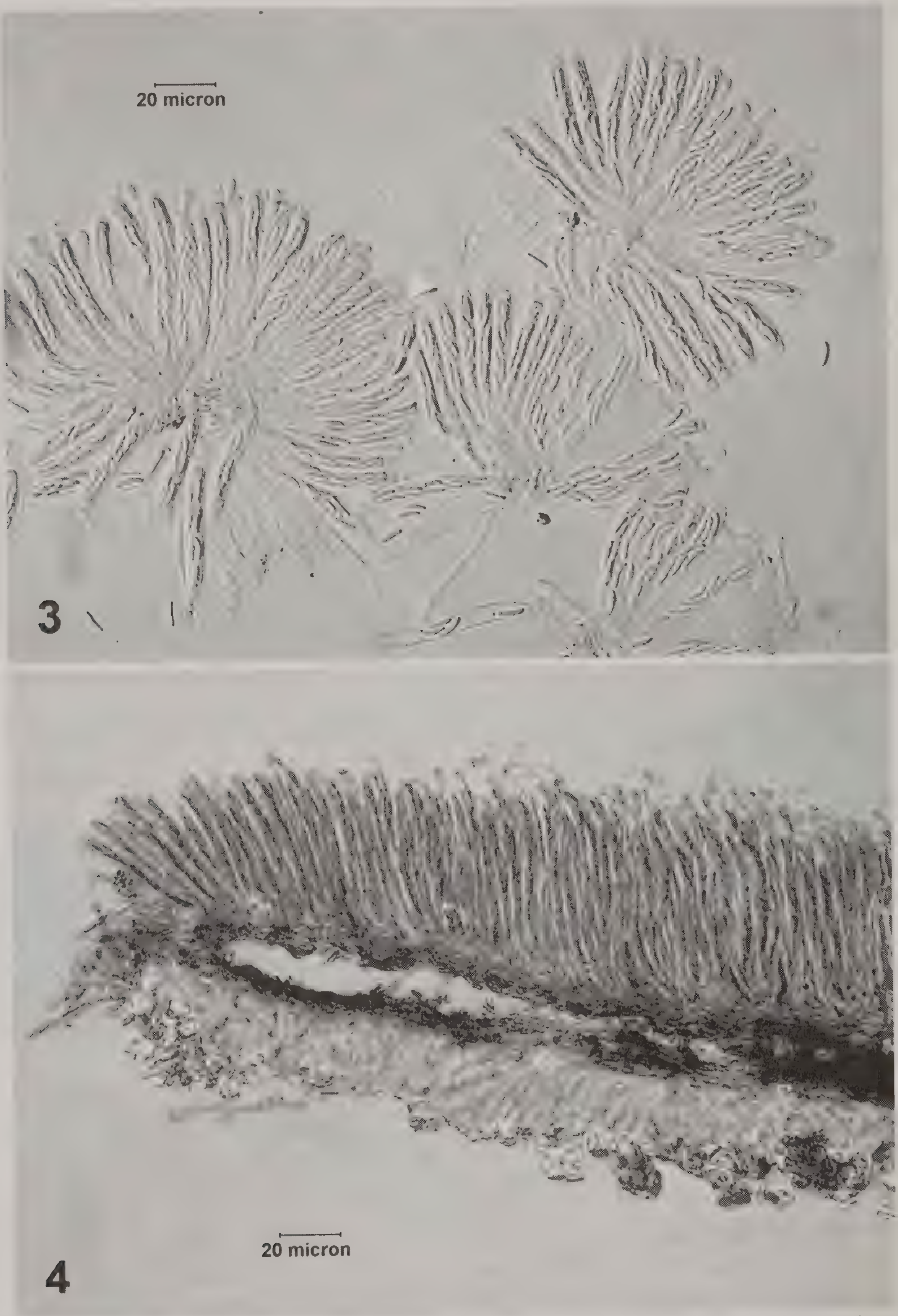
Etymology: The specific epithet refers to ascospore shape.

Apothecia tightly gregarious, about 30–50 in a group forming compound, hemispherical, honeycomb-like fruitbodies, erumpent from bark, 3–4.5 mm in diam. when dry and up to 9 mm in diam. when rehydrated; when young the compound fruitbodies as a course network and without a distinguishable margin; individual apothecia deep-cupulate, sessile, 0.4–0.8 mm diam. when dry and 0.8–1.5 mm diam. when rehydrated, hymenium surface brown to coffee brown when dry and light grayish brown when rehydrated, with apothecial margin much paler when dry and slightly paler than color of hymenium when rehydrated, receptacle surface mostly not exposed except for those around





Figs. 1–2. *Sinofavus allantosporus* (HMAS 173243): **1.** Apothecia on natural substrate, showing young (left) and mature (right) compound fruitbodies; **2.** Section of apothecium mounted in cotton blue, showing hymenium, subhymenium, granulate brown medullary hyphae, and ectal excipular structure.



Figs. 3–4. *Sinofavus allantosporus* (HMAS 173243): **3.** Asci with ascospores and paraphyses mounted in Melzer's reagent, showing the thickened and truncate ascus apices and spore arrangements; **4.** Excipular structure at and near margin, showing the gel matrix in ectal excipulum and hyaline crystals in excipular tissues.

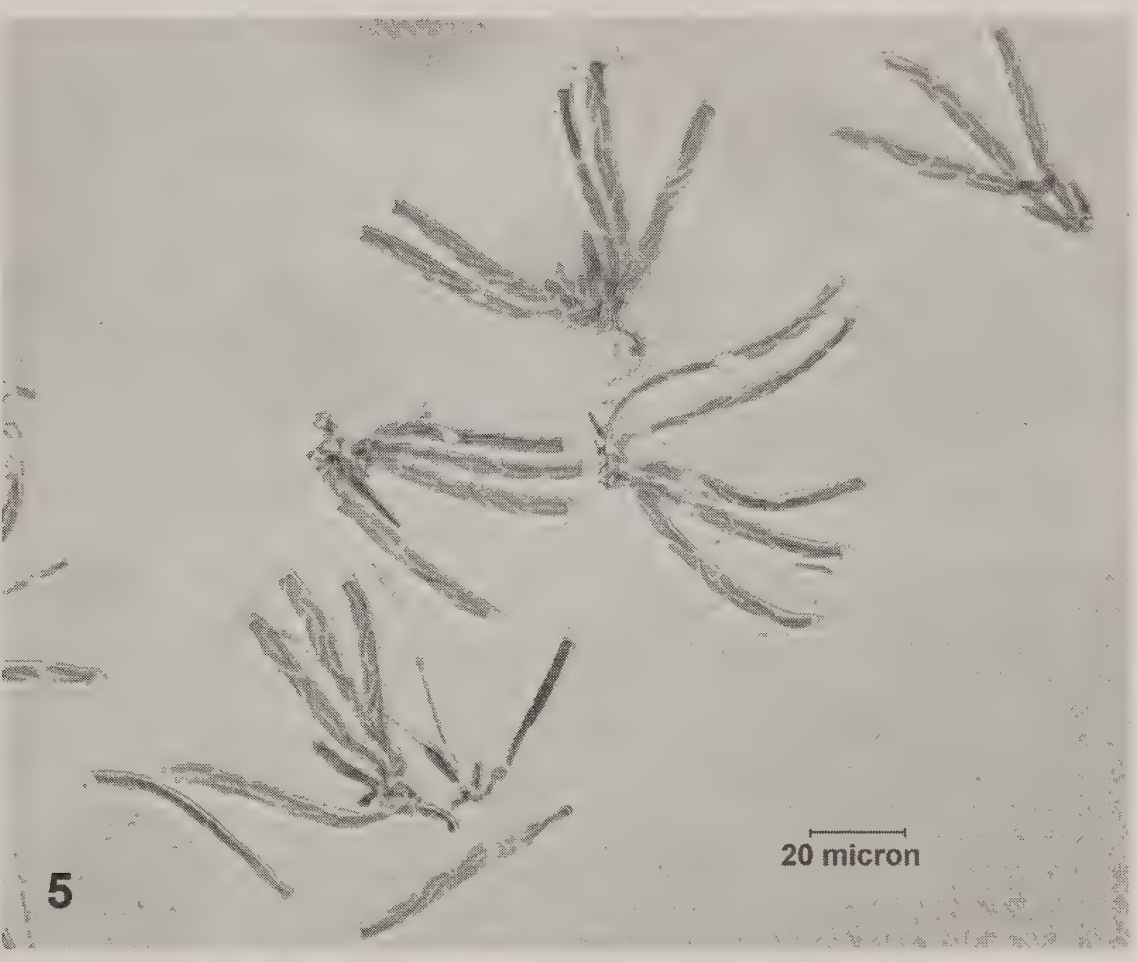


Fig. 5. *Sinofavus allantosporus* (HMAS 173243): Asci with ascospores, showing asci arising from croziers.

margin of the compound fruitbody, pale grayish due to presence of crystals and dark brown when rehydrated; tissues not ionomidotic when treated in aqueous KOH solution; refractive crystals scattered in excipular tissues; ectal excipulum embedded in a gel matrix, of textura intricata, 27–32 µm thick, hyphae hyaline, thin-walled, with blunt ends towards outside, 2–3.2 µm wide, axes of hyphae somewhat perpendicular to the outer surface; medullary excipulum of textura porrecta near the ectal excipulum and of textura intricata in the inner layer, 15–100 µm thick, hyphae brown, finely granulate on surface, 2–4.5 µm wide, axes of hyphae more or less parallel to the outer surface; subhymenium of dense textura intricata, ca 7 µm thick, cell walls faintly pigmented; hymenium 54–64 µm thick; asci inoperculate, 8-spored, arising successively from crosiers, subcylindrical, with apex thickened, and truncate, J– in Melzer's reagent, 50–67 × 5–6 µm; ascospores allantoid to rod-shaped, hyaline, eguttulate, unicellular, biseriate to irregularly biseriate, 7.5–10 × 1.5–1.8 µm; paraphyses filiform, very slightly enlarged at apex, hyaline, septate, 2–3 µm wide at upper portion and 1.5–2 µm below, exceeding the asci 0(–5) µm.

Specimen examined: CHINA. Xinjiang, Tuomer Peak, on dead twig of broadleaf tree in a mixed forest, 2-IX-2007, Tolgor, HMJAU 6017 (**holotype**), HMAS 173243 (**isotype**).

Notes: *Sinofavus allantosporus* is a very characteristic fungus. Its diagnostic features are the combination of tiny, brown, hemispherical, honeycomb-like compound fruitbodies; ectal excipulum of textura intricata embedded in a gel matrix, consisting of hyaline hyphae with rounded ends and axes more or less perpendicular to the outer surface; medullary excipulum not gelatinized, of textura intricata and consisting of finely granulate, brown hyphae running somewhat parallel to the outer surface; subcylindrical asci arising from crosiers and with apex truncate, inamyloid, and thickened; and ascospores allantoid, unicellular and hyaline. The anatomical structure indicates its position in the *Helotiales* (Korf 1973, Korf & Lizon 2000, Eriksson 2006).

Inoperculate cup-fungus genera producing compound fruitbodies or aggregated ones with branched apothecial stipes arising from a common base are *Cordierites* Mont., *Jacobsonia* Boedijn, *Myriodiscus* Boedijn and *Polydiscidium* Wakef. (Boedijn 1935, Wakefield 1935, Dennis 1961, Korf 1973, Zhuang 1988). Among them, *Myriodiscus* is possibly the closest to *Sinofavus* morphologically. Those possessing completely or partially gelatinized apothecial tissues are *Ascocoryne* J.W. Groves & D.E. Wilson, *Ascotremella* Seaver, *Bisporella* Sacc., *Bulgaria* Fr., *Chloroscypha* Seaver, *Claussenomyces* Kirschst., *Crocicreas* Fr., *Gelatinodiscus* Kanouse & A.H. Sm., *Ionomidotis* E.J. Durand, *Neobulgaria* Petr. and *Xeromedulla* Korf & W.Y. Zhuang. However, compound fruitbodies are never produced by these genera. Their apothecia are solitary or a few in a group with a discoid to flat or somewhat convex disc instead of a deep-cupulate one. Anatomically, *Ionomidotis* is probably the closest genus to *Sinofavus* when a single apothecium is compared.

Myriodiscus sparassoides Boedijn on bamboo originally reported from Sumatra, Indonesia with a subglobose compound fruitbody, completely gelatinized excipular tissues with both ectal excipulum and medullary excipulum of textura intricata and not sharply distinguishable, and asci thickened at apex and containing numerous small ellipsoid ascospores (Boedijn 1935) is similar to *S. allantosporus* in the way that apothecia aggregate. A single collection (HMAS 24069) of *M. sparassoides* on deposit in HMAS, filed under its later synonym *Ascotremellopsis bambusicola* Teng & S.H. Ou (Ou 1936, Tai 1979, Liu & Guo 1987) on bamboo from Guangxi Province of China, was also examined and compared. Its morphology is exactly the same as that described and illustrated by Boedijn (1935) in his detailed original description of *M. sparassoides*. Comparison between *S. allantosporus* and *M. sparassoides* reveals that significant differences appear in the excipular structure, arrangement of ectal excipular hyphae, surface morphology and arrangements of medullary excipular hyphae, shape of asci, spore number per ascus, and ascospore shape. Clearly they are not congeneric.

The monotypic genus *Jacobsonia* producing compound fruitbodies differs from *Sinofavus* in the ectal excipulum consisting of a typical pseudoparenchymatic cortex layer with the outer cell layers blue green in color, paraphyses incrusted with a blue green matter and forming a pseudo-epithecium, and ascospores ellipsoid, biguttulate (Boedijn 1935). *Cordierites guianensis* Mont. differs in the apothecia arising from branched stipes from a common base, excipular structure, and ascospore shape and guttulation (Zhuang 1988). And the monotypic *Polydiscidium* is easily distinguished from *Sinofavus* by its branched fruitbodies, highly gelatinized ectal and medullary excipular tissues, and brown, uniseptate and ellipsoid ascospores (Wakefield 1935, Dennis 1961).

When structure of individual apothecia is concerned, *S. allantosporus* is similar to species of *Ionomidotis*. Presence of the gelatinized tissues and interwoven hyphae in the ectal excipulum and allantoid ascospores are features shared by both genera. But the compound fruitbodies, very dark, granulate and non-gelatinized medullary excipular hyphae, thickened ascus apex, presence of refractive crystals in apothecial tissues, as well as the eguttulate ascospores were never found in the latter genus. Furthermore, the apothecial tissues of *S. allantosporus* have no sign of an ionomidotic reaction when treated in aqueous KOH solution, which is diagnostic in species of *Ionomidotis* (Zhuang 1988). Needless to say, they cannot be congeneric.

A new genus is thus proposed based on morphological characteristics. Due to the limitation of available material, DNA extraction is impossible. Molecular evidence of its relation to other genera of the *Helotiales* has not been obtained.

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Literature cited

Boedijn KB. 1935. Two new Malaysian genera of discomycetes. Bull. Jard. Bot. Buitenz Ser. III. 13: 478-483.

Dennis RWG. 1961. A collection of *Polydiscidium* from Africa. Bull. Jardin Bot. L'État Bruxelles 31: 155-157.

Eriksson OE. 2006. Outline of *Ascomycota* – 2006. Myconet 12: 1-82.

Korf RP. 1973. *Discomycetes* and *Tuberales*. pp. 249-319. In Ainsworth GC, Sparrow FK & Sussman AS (eds.), The Fungi: an Advanced Treatise. Vol. 4A. Academic Press. New York & London.

Korf RP, Lizon P. 2000. Validation of Nannfeldt's ordinal name *Helotiales*. Mycotaxon 75: 501-502

Liu XJ, Guo YL. 1987. Confirmation of the synonymy of *Ascotremellopsis* Teng & Ou to *Myriodiscus* Boedijn. Acta Mycol. Sinica Suppl. 1: 97-101 [1986].

Ou SH. 1936. Additional fungi from China IV. Sinensia 7: 668-685.

Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press. Beijing.

Wakefield EM. 1935. Contributions to the flora of tropical America: XXI. Fungi collected in British Guiana, chiefly by the Oxford University Expedition, 1929. Bull. Misc. Inform. 1934: 238-258.

Zhuang WY. 1988. Studies on some discomycete genera with an ionomidotic reaction: *Ionomidotis*, *Poloniodiscus*, *Cordierites*, *Phyllomyces*, and *Ameghiniella*. Mycotaxon 31: 261-298.

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Raffaelea lauricola, a new ambrosia beetle symbiont and pathogen on the *Lauraceae*

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Abstract — An undescribed species of *Raffaelea* earlier was shown to be the cause of a vascular wilt disease known as laurel wilt, a severe disease on redbay (*Persea borbonia*) and other members of the *Lauraceae* in the Atlantic coastal plains of the southeastern USA. The pathogen is likely native to Asia and probably was introduced to the USA in the mycangia of the exotic redbay ambrosia beetle, *Xyleborus glabratus*. Analyses of rDNA sequences indicate that the pathogen is most closely related to other ambrosia beetle symbionts in the monophyletic genus *Raffaelea* in the *Ophiostomatales*. The asexual genus *Raffaelea* includes *Ophiostoma*-like symbionts of xylem-feeding ambrosia beetles, and the laurel wilt pathogen is named *R. lauricola* sp. nov.

Key words — *Ambrosiella, Coleoptera, Scolytidae*

Introduction

A new vascular wilt pathogen has caused substantial mortality of redbay [*Persea borbonia* (L.) Spreng.] and other members of the *Lauraceae* in the coastal plains of South Carolina, Georgia, and northeastern Florida since 2003 (Fraedrich et al. 2008). The fungus apparently was introduced to the Savannah, Georgia, area on solid wood packing material along with the exotic redbay ambrosia beetle, *Xyleborus glabratus* Eichhoff (*Coleoptera: Curculionidae: Scolytinae*), a native of southern Asia (Fraedrich et al. 2008, Rabaglia et al. 2006). As in the case of many ambrosia beetles (Beaver 1989, Harrington 2005), *X. glabratus* has mycangial pouches for carrying fungal symbionts, and the redbay pathogen lives as a budding yeast phase within the mycangium (Fraedrich et al. 2008). Spores of the fungal symbiont ooze out of the mycangium and inoculate the xylem as the adult female constructs her tunnels and lays eggs. The pathogen moves systemically through the vessels of the host and causes a vascular wilt disease similar to Dutch elm disease, which is caused by *Ophiostoma novo-ulmi* Brasier (Fraedrich et al. 2008).

Symbionts of ambrosia beetles are asexual fungi that typically produce small conidiophores in tight clusters (sporodochia) in beetle galleries, and larvae and adults feed on the conidia (Batra 1967). Most ambrosia beetle symbionts have been described in the anamorph genera *Raffaelea* Arx & Hennebert emend. L.R. Batra or *Ambrosiella* Brader emend. L.R. Batra. The two genera were distinguished by sympodial proliferation of the conidiogenous cell in the former, leaving inconspicuous scars along the side, and percurrent profileration, leaving rings at the tip of the conidiogenous cell, in the latter (Batra 1967). However, these distinctions are difficult to discern and are questionable criteria for distinguishing the anamorph genera associated with *Ophiostoma* Sydow & P. Sydow (Gebhardt & Oberwinkler 2005, Harrington 1993), to which most ambrosia beetle symbionts seem to be related (Harrington 2005).

Previously, phylogenetic analyses of rDNA sequences suggested that *Raffaelea* species and some other ambrosia beetle symbionts comprise a monophyletic group arising within *Ophiostoma* (Gebhardt et al. 2005, Jones & Blackwell 1998, Rollins et al. 2001). However, three *Ambrosiella* species, including the type species, *A. xylebori* Brader ex Arx & Hennebert, have phialidic conidial development and are relatives of *Ceratocystis* Ellis & Halst. (Cassar & Blackwell 1996, Gebhardt et al. 2005, Paulin & Harrington 2000). *Dryadomyces* is closely related to the other *Ophiostoma*-like symbionts of ambrosia beetles and appears to fall into the *Raffaelea* "clade," but its conidiogenous cells differ from those of *Raffaelea* spp. because the conidiogenous cells have denticles at the point of conidial dehiscence (Gebhardt et al. 2005). Otherwise, *D. amasae* fits ecologically and phylogenetically with the other *Ophiostoma*-like symbionts (Gebhardt et al. 2005). The monophyletic and asexual genus *Raffaelea* would appear to be the best available name for all ambrosia beetle symbionts with affinities to *Ophiostoma*, at least until the taxonomy of the large and diverse genus *Ophiostoma* is better resolved.

The laurel wilt pathogen was shown by analyses of rDNA sequences (EU123076, EU123077) to occur in the monophyletic group of species with *Raffaelea* and other asexual fungi associated with ambrosia beetles (Fraedrich et al. 2008). The laurel wilt pathogen, like *Ophiostoma* species and related anamorphs, tolerates cycloheximide (Cassar & Blackwell 1996, Harrington 1981). Also, the pathogen produces conidiophores and conidia similar to those of other ambrosia beetle symbionts that are related to the *Ophiostoma* clade (Kubono & Ito 2002). The new species appears to be most appropriately placed in the anamorph genus *Raffaelea*.

Materials & methods

Cultures of the new species were obtained from dead or dying trees or isolated directly from adult females of *X. glabratus*. Representative cultures are maintained in the collection of the senior author. The holotype specimen was deposited in the U.S. National Fungus Collections, USDA, Beltsville (BPI), and the ex-type was deposited in the Centraalbureau voor Schimmelcultures, Fungal Biodiversity Center, the Netherlands (CBS).

Morphological descriptions were made from cultures on malt extract agar (MEA, 1.5% Difco malt extract and 1.5% agar) at 25 C in the dark. Mycelial colors are described using terminology from Rayner (1970). Growth at 10, 15, 25, 30 and 35 C after 10 days was also determined on MEA.

Taxonomy

Raffaelea Arx & Hennebert **emend.** T.C. Harr.

= *Dryadomyces* Gebhardt, Mycol. Res. 109: 693. 2005.

Condiophores single to aggregated in sporodochia, hyaline, unbranched or sparingly branched, one-celled to septate, producing terminal conidia holoblastically. Conidiogenous cells proliferating percurrently or sympodially, leaving denticles, inconspicuous scars or annelations. Conidia small, hyaline, elliptical to ovoidal to globose, slimy, secession schizolytic, producing yeast-like growth through budding. Tolerating cycloheximide in culture. Associated with ambrosia beetles.

Type Species —***Raffaelea ambrosiae*** Arx & Hennebert, Mycol. Mycopathol. Appl. 25: 310. 1965.

Raffaelea lauricola T.C. Harr., Fraedrich & Aghayeva **sp. nov.** Figure 1

MycoBank MB 511590

Coloniae in agaro (MEA) post 10 dies ad 25 C, 65 mm diam, cremae-bubalinae, mucosae. Conidia blastosporae, oblongatae vel ovatae, 3.5–4.5 × 1.5–2.0 µm. Socius cum Xyleborus glabratus.

Holotype—**UNITED STATES. South Carolina:** Hunting Island State Park, from *Xyleborus glabratus*, June 2006, S. Fraedrich, BPI 878183, from isolate C2339 (= CBS 121567).

Maximum growth on malt extract agar at 25 C, colony diameter 60 mm diam. at 25 C, 10 mm diam. or less at 10 and 30 C. Colony at 10 days cream-buff, smooth, but later mucilaginous in the center, margins of colony uneven, side branches of submerged hyphae at advancing front producing conidia and tight clusters of blastoconidia; 2 week old colonies cottony, honey yellow, and with a yeasty odor. Conidiophores hyaline, usually aseptate and unbranched but sometimes septate at branches, terminal or arising as a side branch from hyphae, variable in length but mostly (8.5)13–60(120) × (1.0)2.0(2.5) μm wide. Conidia produced holoblastically, at the tip of the conidiogenous cell, but not leaving conspicuous scars or annelations, primary conidia oblong to obovoid, sometimes flattened at the point of attachment, hyaline, thin walled, (3.0)3.5–4.5(8.0) × (1.0)1.5–2.0(3.5) μm; budding new cells, the blastospores forming in a cluster at the tip of the conidiophore and a slimy mass over the central part of the colony.

Cultures examined—UNITED STATES. South Carolina: Hunting Island State Park, from *Persea borbonia*, September 2005, S. Fraedrich, C2214; Georgia: Pembroke, from *P. borbonia,* December 2005, S. Fraedrich, C2245; Florida: Fort George Island, from *P. borbonia,* December 2005, S. Fraedrich, C2258.

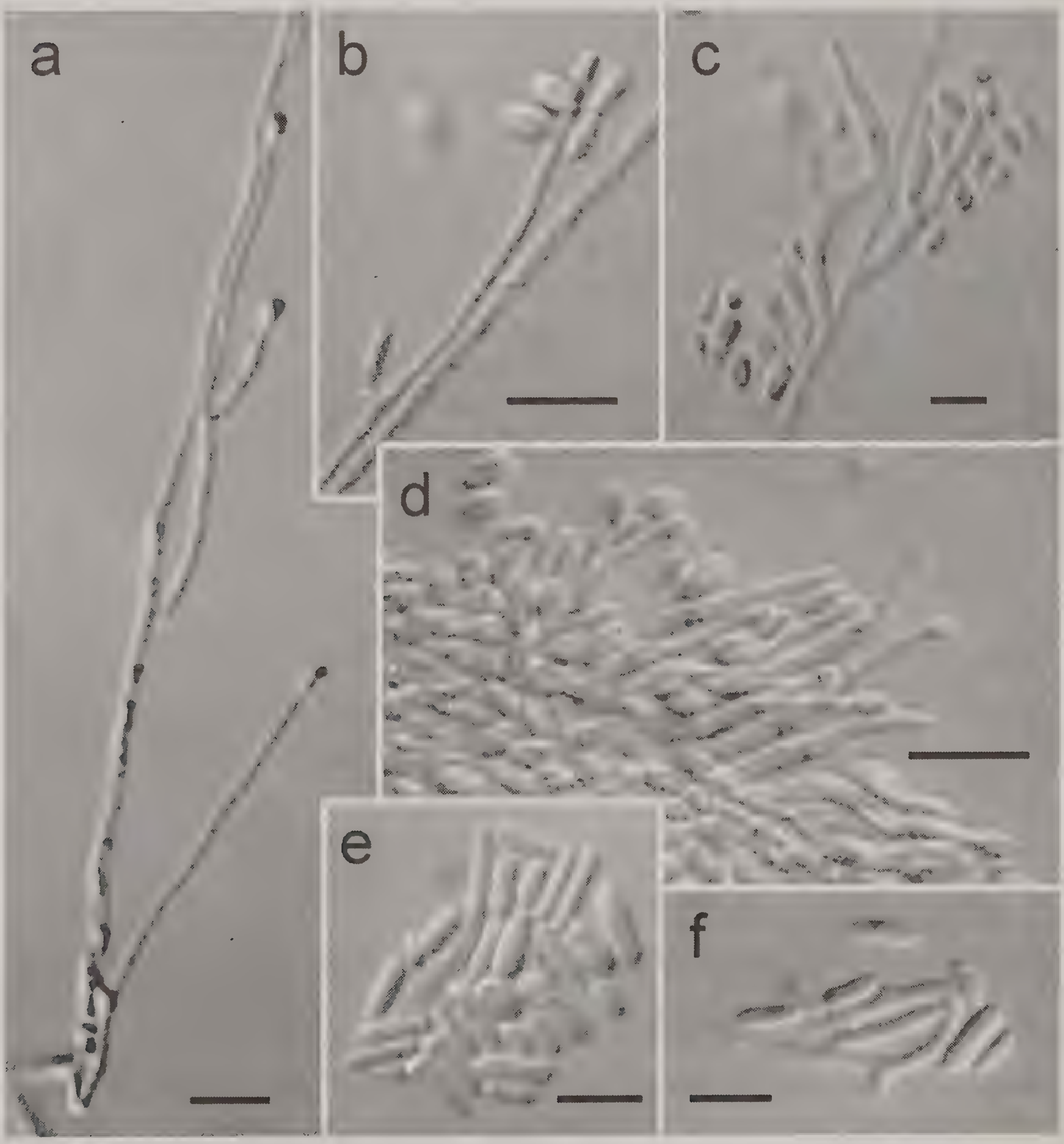

Fig. 1. Conidiophores, conidia and budding yeast cells of *Raffaelea lauricola*. Bars in all figures are 10 μm.

Comments — In cultures initiated from spores, *R. lauricola* forms colonies that are initially highly mucilaginous, but then submerged hyphae grow from the colony margin, and clusters of yeast-like conidia form on the short side branches of the hyphae. The conidiophores are small and hyaline, conidiogenous cells lack conspicuous scars or annelations at the point of conidial dehiscence, similar to the generic concept of the anamorph *Hyalorhinocladiella*, a common anamorph of *Ophiostoma* spp. (de Hoog 1993). The anamorph genus *Raffaelea* includes ambrosia beetle symbionts that produce conidiophores similar to *Hyalorhinocladiella*, but in *Raffaelea* the conidiophores are grouped into sporodochia (Batra 1967). Clumping of conidiophores is sometimes seen in vitro, which may represent incompletely formed sporodochia. Like other species of *Raffaelea*, the new taxon tolerates high concentrations of cycloheximide (Cassar & Blackwell 1996).

Earlier work based on rDNA sequences placed *R. lauricola* among species of *Ophiostoma* and their anamorphs (Fraedrich et al. 2008). The SSU rDNA sequences placed the fungus near *Ambrosiella brunnea*, which has been associated with *Monarthrum* spp. in the eastern USA (Batra 1967). The conidia of *A. brunnea* are larger than those of *R. lauricola*, and *A. brunnea* produces yellow to brown mycelium in culture, while *R. lauricola* has only hyaline hyphae.

Conidia and conidiophores of *R. lauricola* are similar to those of the recently-described *R. quercivora* Kubono & Shin. Ito, though *R. quercivora* has a faster growth rate and pale-olive to brown-olive cultures at 2 weeks, and its conidia are broader (Kubono & Ito 2002). No rDNA sequences of *R. quercivora* are available. *Raffaelea quercivora* is associated with *Platypus quercivorus* (Murayama), which attacks living oaks in Japan. The fungus is capable of causing lesions in inoculated seedlings but does not cause a vascular wilt disease (Kinura & Kobayashi 2006, Murata et al. 2005, Murata et al. 2007). To date, *R. lauricola* is the only known ambrosia beetle symbiont that moves systemically throughout the host and causes a true vascular wilt disease (Fraedrich et al. 2008).

Raffaelea lauricola is readily isolated from the mycangia of the exotic beetle *X. glabratus*, and we assume that the fungus was brought to the USA from Asia with its vector in solid wood packing material (Fraedrich et al. 2008). The fungus has been isolated from diseased redbay in South Carolina, Georgia, and Florida in association with *X. glabratus*, and there has been serious redbay mortality wherever the fungus and beetle vector have been encountered (Fraedrich et al. 2008). In addition it also causes a vascular wilt disease in native *Sassafras albidum* (Nutt.) Nees, *Lindera melissifolia* (Walter) Blume, *Litsea aestivalis* (L.) Fernald, and avocado (*Persea americana* Mill.) (Fraedrich et al. 2008), all new world members of the family *Lauraceae*. Perhaps the *Lauraceae* native to Asia are more resistant to the pathogen, but this has not been tested.

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Literature cited

Batra LR. 1967. Ambrosia fungi: A taxonomic revision and nutritional studies of some species. Mycologia 59: 976-1017.

Beaver RA. 1989. Insect-fungus relationships in the bark and ambrosia beetles. Pp. 121-143 In: Insect-Fungus Interactions. N. Wilding, N.M. Collins, P.M. Hammond, and J.F. Webber, eds. Academic Press, London.

Cassar S, Blackwell M. 1996. Convergent origins of ambrosia fungi. Mycologia 88: 596-601.

De Hoog GS. 1993. *Sporothrix*-like anamorphs of *Ophiostoma* species and other fungi. Pp. 53-70 in: *Ceratocystis* and *Ophiostoma*. Taxonomy, ecology, and pathogenicity. M. J. Wingfield, K. A. Seifert, and J. F. Webber, eds. American Phytopathological Society Press, St. Paul, Minnesota.

Fraedrich SW, Harrington TC, Rabaglia RJ, Ulyshen MD, Mayfield AE, Hanula JL, Eickwort JM, Miller DR. 2008. A fungal symbiont of the redbay ambrosia beetle causes a lethal wilt in redbay and other *Lauraceae* in the southeastern United States. Plant Dis. 92: 215-224.

Gebhardt H, Oberwinkler F. 2005. Conidial development in selected ambrosial species of the genus *Raffaelea*. Antonie von Leeuwenhoek 88: 61-66.

Gebhardt H, Weiss M, Oberwinkler F. 2005. *Dryadomyces amasae*: a nutritional fungus associated with ambrosia beetles of the genus *Amasa* (*Coleoptera: Curculionidae, Scolytinae*). Mycol. Res. 109: 687-696.

Harrington TC. 1981. Cycloheximide sensitivity as a taxonomic character in *Ceratocystis*. Mycologia 73: 1123-1129.

Harrington TC. 1993. Diseases of conifers caused by *Ophiostoma* and *Leptographium*. Pp. 161-172 In: M. J. Wingfield, K. A. Seifert and J. F. Webber, eds. *Ceratocystis* and *Ophiostoma*. Taxonomy, ecology and pathogenicity. APS Press, St. Paul, Minnesota.

Harrington TC. 2005. Ecology and evolution of mycophagous bark beetles and their fungal partners. Pp. 257-292 In: Insect-Fungal Associations: Ecology and Evolution. Vega, F. E. And M. Blackwell, eds. Oxford University Press, Inc. New York.

Jones KG, Blackwell M. 1998. Phylogenetic analysis of ambrosial species in the genus *Raffaelea* based on 18S rDNA sequences. Mycol. Res. 102: 661-665.

Kinuura H, Kobayashi M. 2006. Death of *Quercus crispula* by inoculation with adult *Platypus quercivorus* (*Coleoptera: Platypodidae*). Appl. Entomol. Zool. 41: 123-128.

Kubono T, Ito S. 2002. *Raffaelea quercivora* sp. nov. associated with mass mortality of Japanese oak, and the ambrosia beetle (*Platypus quercivorus*). Mycoscience 43: 255-260.

Murata M, Yamada T, Ito S. 2005. Changes in water status in seedlings of six species in the Fagaceae after inoculation with *Raffaelea quercivora* Kubono et Shin-Ito. J. For. Res. 10: 251-255.

Murata M, Yamada T, Matsuda Y, Ito S. 2007. Discolored and non-conducive sapwood among six Fagaceae species inoculated with *Raffaelea quercivora*. For. Pathol. 37: 73-79.

Paulin AE, Harrington TC. 2000. Phylogenetic placement of anamorphic species of *Chalara* among *Ceratocystis* species and other ascomycetes. Stud. Mycol. 45: 209-222.

Rabaglia RJ, Dole SA, Cognato AI. 2006. Review of American *Xyleborina* (*Coleoptera: Curculionidae: Scolytinae*) occurring north of Mexico, with an illustrated key. Ann. Entomol. Soc. Am. 99: 1034-1056.

Rayner RW. 1970. A mycological colour chart. Commonwealth Mycological Institute, Kew, Surrey & British Mycological Society.

Rollins F, Jones KG, Krokene P, Solheim H, Blackwell M. 2001. Phylogeny of asexual fungi associated with bark and ambrosia beetles. Mycologia 93: 991-996.

MYCOTAXON

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Revision of taxa of the URM Herbarium 2. *Hypoxylon* species described by A.C. Batista

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Abstract — Three species of *Hypoxylon* described by A.C. Batista were revised. *Hypoxylon bombacinum* is confirmed as a valid species while *H. calyptra* and *H. vitalii* are considered synonyms of *H. rubiginosum* and *Whalleya maculata*, respectively.

Key words — *Hypoxylon maculatum*, systematic, *Xylariaceae*

Introduction

Three *Hypoxylon* species described in the 1950's by the Brazilian mycologist A.C. Batista and deposited in the URM and IPA herbarium (Recife, Pernambuco, Brazil) — *H. bombacinum*, *H. calyptra* and *H. vitalii* — were examined (Batista 1950, Batista & Oliveira 1959). In his monograph of the world species of *Hypoxylon*, Miller (1961) did not consider Batista's species, probably because he had no access to Batista's papers. Further studies on *Xylariaceae* in Recife and adjacent areas were conducted by Poroca (1976, 1986), who considered *H. calyptra* and *H. vitalii* to be synonyms of *H. rubiginosum* and *H. maculatum* respectively and who retained *H. bombacinum* as a valid species. Ju & Rogers (1996) were uncertain the identities of *H. bombacinum*, *H. calyptra* and *H. vitalii* because they did not have an access to the holotypes.

Index Fungorum (CABI, 2008) lists Batista's *Hypoxylon* species without comment, while the three species are included only in the list of names on the website maintained by Ju et al. (2008).

Materials and methods

The types of *H. bombacinum*, *H. calyptra* and *H. vitalii* were analyzed macroscopically and microscopically following the methods set forth by Ju & Rogers (1996) and Rogers et al. (1997). The Color Identification Chart of Watling (1969) was utilized to describe the species.

Taxonomy

Hypoxylon bombacinum Bat. & Oliveira, An. Soc. Biol. Pernambuco 16: 163. 1959.

Stromata effused-pulvinate or hemispherical, 12-30 mm broad; surface dark with reddish granules (Rust 13) immediately beneath surface and between perithecia, with KOH-extractable pigments brownish-yellow (Fulvous 12). Perithecia obovoid to tubular, 360-410 µm diam and 380-530 µm high. Ostioles lower than the stromatal surface. Asci collapsed, not possible to measure, with an apical ring bluing in Melzer's reagent. Ascospores brown to dark brown (Umber 18), unicellular, ellipsoid-inequilateral, with narrowly rounded ends, 12-17 × 7-8 µm, with straight germ slit spore-length; perispore dehiscent in 10% KOH, smooth or with inconspicuous coil-like ornamentation; epispore smooth.

Specimen examined: BRAZIL: Pernambuco, Recife, Ponte D'Uchoa, 19.VIII.1956, A. Vital, in decorticated wood of *Bombax pentaphyllum* Vell. (URM 5755, HOLOTYPE).

Notes: The combination of characters (reddish granules beneath the stromatal surface, brownish-yellow pigments in KOH, and ascospore size) does not match any taxon included in current keys to *Hypoxylon* species. Ju & Rogers (1996) commented on the possibility of *H. bombacinum* being a synonym of *H. subrutilum* Starbäck, but the spherical perithecia and larger ascospores of the latter species allow us to conclude that they are distinct species. Unfortunately, the type material is somewhat ruined and certain structures such as asci are no longer measurable. Efforts are being made to recollect the species in the State of Pernambuco.

Hypoxylon rubiginosum (Pers.: Fr.) Fr., Summa Veg. Scand. II, p. 384. 1849.
= *Hypoxylon calyptra* Bat., Bol. Secr. Agric. (Recife) 17: 61. 1950.

Stromata effused-pulvinate; perithecial mounds, 7-15 × 5-7 mm broad and 0.5-1 mm thick; surface dark with brown granules (Rust tawny 14) immediately beneath surface and between perithecia, with KOH-extractable pigments ferruginous (Rust 13), the tissue below the perithecial layer usually inconspicuous. Perithecia spherical to obovoid, 420-500 µm diam and 520-600 µm high. Ostioles lower than the stromatal surface. Asci 115-140 µm total length and 6-7 µm broad, the spore-bearing parts 65-80 µm long, the stipes 50-60 µm long, with apical ring bluing in Melzer's reagent, discoid. Ascospores brown to dark brown (Bay 19), unicellular, ellipsoid-inequilateral, with narrowly rounded ends, 11-12 × 5-5.5 µm, with straight germ slit spore-length; perispore dehiscent in 10% KOH, smooth or with inconspicuous coil-like ornamentation; epispore smooth.

Specimens examined: BRAZIL: Pernambuco, Recife, Casa Amarela, 2.VIII.1947, A. Vital, as *Hypoxylon calyptra* (IPA 958, HOLOTYPE); Pernambuco, Recife, Jardim Zoo-Botânico, 28.VIII.1947, Bat., corticated wood, as *Hypoxylon calyptra* (URM 713, PARATYPE).

Notes: In his original description of *H. calyptra,* Batista (1950) did not discuss the extraction of pigments in KOH, the reaction of apical rings with Melzer´s reagent, the germ slit disposition, or dehiscence and ornamentation of perispore. Examination of these characters and observation of the stromatal surface in the *H. calyptra* specimens allows us to place the name *H. calyptra* into synonymy with *H. rubiginosum*. Poroca (1976) also came to the same conclusion, but she did not discuss the above characters.

Whalleya maculata (Theiss.) J.D. Rogers, Y.M. Ju & F. San Martín,
Mycotaxon 64: 49. 1997.
= *Hypoxylon vitalii* Bat., Bol. Secr. Agric. (Recife) 17: 62. 1950.

Stromata applanate, solitary or confluent, 8-69 × 6-24 mm, without extractable pigments in KOH, outer layer dark brown (Cigar brown 16), thin, with mature black surface; white tissue between perithecia, becoming brownish; the tissue below the perithecial layer inconspicuous. Perithecia globose or elongated, 310-390 × 198-265 µm. Ostioles lower than the level of stromatal surface and appearing punctate on the stromatal surface. Asci 8-spores, cylindrical, short-stipitate, with an apical amyloid rings in Melzer´s reagent. Ascospores 5-6.5 × 2-2.5 µm, light brown (Snuff brown 17), ellipsoid-inequilateral, with a straight germ slit; perispore indehiscent in 10% KOH; epispore smooth.

Specimens examined: BRAZIL: Pernambuco, Recife, Jardim Zoo-Botânico, 26.VII.1947, A. Vital, corticated wood, as *Hypoxylon vitalii* (IPA 959, HOLOTYPE; URM 712, ISOTYPE).

Notes: The characters shown in the Batista's specimen of *Hypoxylon vitalii* match well those of *W. maculata* (Rogers et al., 1997). *Whalleya maculata* is similar to the type species of the genus, *W. microplaca,* but differs mainly in having larger perithecia and a different host preference.

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References

Batista AC. 1950. Cinco novos ascomicetos de Pernambuco. Bol. Secr. Agric. (Recife) 17: 60-65.

Batista AC, Oliveira TJ. 1959. Algumas espécies de *Ascomycetes*. An. Soc. de Biol. Pernambuco 16: 161-174.

CABI Bioscience. <http://www.indexfungorum.org.br>. Accessed on 01/14/2008.

Ju Y-M, Rogers JD. 1996. A revision of the genus *Hypoxylon*. Mycologia Memoir No. 20. St. Paul: APS Press. 365pp.

Ju Y-M, Rogers JD, Adams MJ. Home of the *Xylariaceae* (The genus *Hypoxylon*) <http://mycology.sinica.edu.tw/xylariaceae/default.asp> Access on 01/14/2008.

Miller JH. 1961. A monograph of the world species of *Hypoxylon*. Univ. Georgia Press, Athens. 158 pp.

Poroca DJM. 1976. *Xylariaceae* do Recife e áreas limítrofes. Dissertação de Mestrado. Universidade Federal de Pernambuco. 203 pp.

Poroca DJM. 1986. Revisão histórica das *Xylariaceae* do Brasil. Boletín Micológico 15: 41-53.

Rogers JD, Ju Y-M, San Martín F. 1997. *Jumillera* and *Whalleya*, new genera segregated from *Biscogniauxia*. Mycotaxon 64: 39-50.

Watling R. 1969. Color Identification Chart. Edinburgh: Her Majesty's Stationery Office.

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A new species of the lichen genus *Brigantiaea* from India

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Abstract— The new species *Brigantiaea patwardhanii* is characterized by a greyish-white thallus without vegetative diaspores, epruinose, black apothecium discs, orange to rust red or black margin and a biatorine exciple, is described from India.

Key words—taxonomy, ascomycetes

Introduction

The genus *Brigantiaea* was described by Trevisan (1853a) to accommodate the single species *B. mariae* and was treated in more detail in later publications (Trevisan 1853b, c) and further species have been added since (Hafellner 1997). In the treatment by Trevisan (1856), which was regarded by Hafellner (1997) as the first monograph of *Brigantiaea*, species descriptions were given. However, the genus was not accepted by other lichenologists and was synonymized with *Lopadium* Körb. Later, Santesson (1952) noted that the taxa of the genus *Brigantiaea* are quite distinct from the typical species of *Lopadium* with which the genus *Brigantiaea* had been synonymized.

Some years later *Brigantiaea* was accepted as an independent genus by various lichenologists (Santesson 1970, Poelt 1974, Kurokawa & Kashiwadani 1977, Poelt & Vězda 1981, Awasthi & Srivastava 1989, Purvis 1992), although it was placed in different families by the different authorities.

The asci of *Brigantiaea* species were studied in detail by Hafellner & Bellemère (1982) who found that the ascal walls are amyloid externally and internal layers are running down towards the base. The internal wall layer is apically enlarged into a tholus without any detectable structural features. In his world monograph of *Brigantiaea*, Hafellner followed Santesson's (1970) view and placed the genus in an independent family *Brigantiaceae.*

The genus *Brigantiaea* in its present circumscription (Hafellner 1997) is characterized by: crustose, smooth, granular to subverrucose or verrucose, whitish-grey to grey thallus, usually limited by a brown-black hypothallus.

Apothecia sessile, constricted at the base, orange, fulvous-brown to brown-black; margin prominent, paler than the disc; exciple biatorine (rarely lecideine), K+ violet-blue (anthraquinone present); epihymenium usually with granular incrustations, K+ violet; hymenium hyaline. Asci (*Brigantiaea*-type) usually 1-spored, bitunicate, I+ blue. Ascospores hyaline, multicelled, muriform; paraphyses simple, rarely branched, compact or discrete, and the occurrence of anthraquinones in the apothecia but not in the thallus, in which atranorin is a constant lichen substance.

In the world wide monograph of Hafellner (Hafellner 1997) recorded fifteen species of *Brigantiaea* and recently, one more species, from Brazil, has now been placed in this genus, viz. *Brigantiaea subobscurata* (Vain.) Aptroot (Aptroot 2002).

Four species of *Brigantiaea* viz. *B. ionoexcipula* (Patw. & Makhija) D.D. Awasthi, *B. leucoxantha* (Spreng.) R. Sant. & Hafellner, *B. nigra* D.D. Awasthi, and *B. pulchra* (Müll. Arg.) Hafellner, have so far been reported from India (Awasthi & Srivastava 1989, Awasthi 1991, 2000). Of these species, *Brigantiaea pulchra* has since been excluded from this genus (Hafellner 1997).

At present we are undertaking a major survey of the lichens of the Maharashtra state of India, and have reexamined the authentic material of several species recorded earlier from this region. One species which was earlier reported as an unnamed species of the genus *Lopadium* by Patwardhan & Makhija (1981) has been found to be a new species of *Brigantiaea* and is described below.

Materials & methods

Sections of the thalli and apothecia were mounted in water, 10% KOH (K), Lugol's Iodine solution (I), and lactophenol cotton blue (LCB). All measurements were made on specimens mounted in water. The iodine reaction of the asci was studied in Lugol's solution after pretreatment with K. Lichen substances were determined by the standard method of TLC (Culberson & Kristinsson, 1970, White & James, 1985) using solvent systems benzene-dioxane-acetic acid (180:45:5), hexane-ethyl ether-formic acid (130:80:20) and toluene-ethyl acetate-formic acid (139:83:8). Specimens were examined for their fluorescence under the long wave length (365nm) UV light.

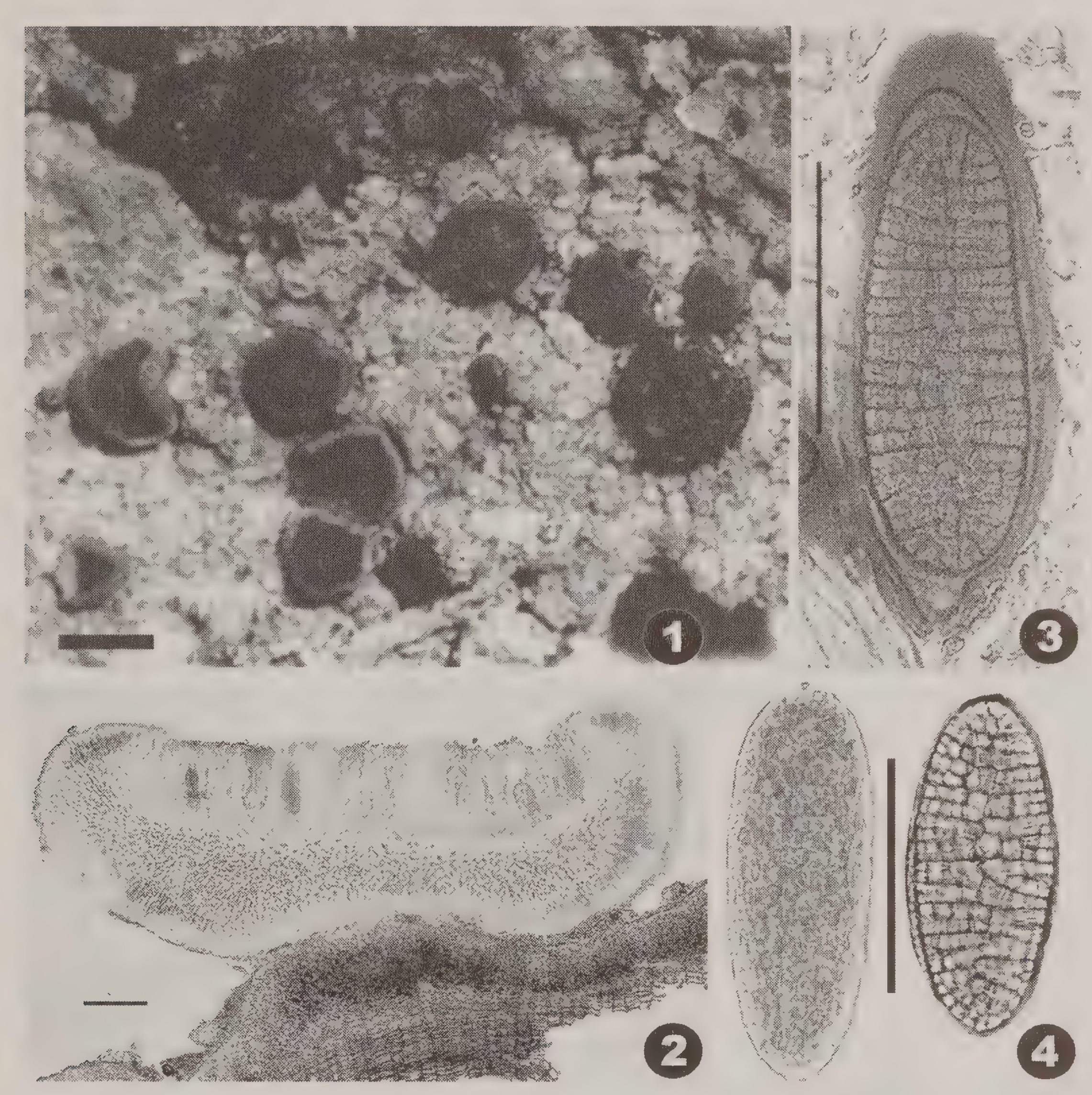
Taxonomic description

Brigantiaea patwardhanii Chitale & Makhija, **sp. nov.** **Figs. 1-4**

MycoBank mb511619

Brigantiaeae nigrae *valde similis sed apothecia epruinosa et ascosporis minoribus.*

Etymology: in honour of the late lichenologist Dr. P.G. Patwardhan.



Figures—1-4. (Holotype) 1) Habit *Brigantiaea patwardhanii* (74.2382) Bar = 1 mm; 2) Vertical section of Apothecia showing biatorine exciple Bar = 100 µm; 3) Ascospore within ascus Bar = 50 µm; 4) Ascospores Bar = 50 µm.

Holotypus—India, Maharashtra, Sindhudurg District, Amboli, about 700 m alt., 8.12.1974, *P.G. Patwardhan & M.B. Nagarkar, 74.2382*; holotype: AMH.

THALLUS crustose, corticolous, greenish-grey, more or less unevenly thickened, cracked with age, without vegetative diaspores, not isidiate, not sorediate; hypothallus thin, black. APOTHECIA solitary, round, 0.5-1.8 mm in diam., sessile to basally constricted. DISC black, concave, plane or convex, epruinose; margin prominent, orange, rust red or black (at maturity), K+ violet. EXCIPLE biatorine, marginal part of the exciple with radially arranged hyphae, often with brownish pigments in medullary part, K+violet. EPIHYMENIUM 12-24 µm tall, K+ violet. HYMENIUM hyaline, 125-160 µm tall, K-, I+ blue. PARAPHYSES simple, sparingly branched at tips. HYPOTHECIUM light brown, 68-79 µm thick, K-.

ASCI 1-spored, cylindrical, clavate, 65-125 × 24-45 µm, I+ blue. ASCOSPORES hyaline, yellowish-brown at maturity, muriform, oval, ellipsoidal, 55-105 × 24-38 µm.

CHEMISTRY—Thallus K+ yellow, C-, KC+ yellow, P+ yellow; UV-; atranorin present.

DISTRIBUTION—India (Kerala & Maharashtra).

ADDITIONAL SPECIMENS EXAMINED—India, **Kerala,** Thekadi, 26.9.1973, P.G. Patwardhan & M.B. Nagarkar, 73.2413, 73.2414, 73.2504 (AMH); Peermade, 27.9.1973, P.G. Patwardhan & M.B. Nagarkar, 73.2592 (AMH).

REMARKS—The new species *Brigantiaea patwardhanii* is characterized by a greyish-white thallus, lacking vegetative diaspores; apothecia black, K+ violet; margin of apothecia orange, rust red to black; exciple biatorine, K+ violet, hypothecium light brown, K-, and ascospores of 55-105 × 24-38 µm size.

The apothecia of most *Brigantiaea* species are densely coloured due to heavy impregnation with anthraquinone crystals. Only in *B. ionoexcipula* the apothecia are always completely black, with quinonoid substances visible only in sections (Hafellner 1997). Thus the new species *B. patwardhanii* comes somewhat close to *B. ionoexcipula* with respect to the black apothecia but *B. ionoexcipula* differs in having lecideine margins, a black exciple and a greenish-black hypothecium.

The new species is also close to *Brigantiaea nigra* with respect to the black apothecial disc and biatorine exciple, but that species differs in having blackish apothecial disc with dark brown to purple pruina, larger ascospores (90-130 × 25-45 µm) and zeorin with atranorin. Thus the new species stands distinct amongst all known species of *Brigantiaea.*

This species was previously recorded as an unnamed species of *Lopadium* from the Western Ghats of India (Patwardhan & Makhija 1981). It has now been formally described and named as *B. patwardhanii* after Dr. Patwardhan who recently passed away and is dedicated to him for his contributions to lichenology.

This corticolous species has been collected on roadside trees at higher elevations in montane rain forest areas and seems to be endemic to Western Ghats of India.

Acknowledgements

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Literature cited

Aptroot A. 2002. New and interesting lichens and lichenicolous fungi in Brazil. Fungal Divers., **9**: 15-45.

Awasthi DD. 1991. A key to the microlichens of India, Nepal and Sri Lanka. Bibl. Lichenol., **40**: 1-337. Publ. J Cramer Berlin Stuttgart.

Awasthi DD. 2000. Lichenology in Indian subcontinent, Dehra Dun- (India), Pub.: Bishen Singh Mahendra Pal Singh, 1-123.

Awasthi DD, Srivastava P. 1989. Lichen genera *Brigantiaea* and *Letrouitia* from India. Proc. Indian Acad. Sci. (Plant Sci.), **99(3)**: 165-177.

Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. J. Chromatogr., **46**: 85-93.

Hafellner J. 1997. A world monograph of *Brigantiaea* (lichenized *Ascomycotina, Lecanorales*). Acta Univ. Ups. Symb. Bot. Ups. **32(1)**: 35-74.

Hafellner J, Bellemere A. 1982. Elektronenoptische Untersuchungen an Arten der Flechtengattung *Brigantiaea*. Nova Hedwigia, **35**: 237-261.

Kurokawa S, Kashiwadani H. 1977. Notes on the genus *Lopadium* in Japan and Formosa. Bull. Nat. Sci. Mus., Ser. B (Bot.), **3/4**: 123-134.

Patwardhan PG, Makhija U. 1981. The lichen genus *Lopadium* (Family *Lecideaceae*) in the Western Ghats, south western India. Indian J. Bot., **4(1)**: 20-26.

Poelt J. 1974. Classification; in The Lichens. Appendix A (eds.) V. Ahmadjian and M.E. Hale (New York: Academic Press) pp. 599-632.

Poelt J, Vězda A. 1981. Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft II. Bibl. Lichenol., **16**:1-390.

Purvis OW. 1992. *Brigantiaea* Trevisan (1853). In: Purvis, OW, Coppins BJ, Hawksworth DL, James PW & Moore DM. (eds.). The lichen flora of Great Britain and Ireland, p. 123. London: Natural History Museum Publications.

Santesson J. 1970. Neuere Probleme der Flechtenchemie. Vorträge Gesamtgebiet Bot., Deutsch. Bot. Ges. N. F. **4**: 5-21.

Santesson R. 1952. Foliicolous lichens. I. A revision of the taxonomy of the obligately foliicolous lichenized fungi. Symb. Bot. Ups. **12(1)**: 1-590.

Trevisan V. 1853a. Saggio di una classazione naturale dei licheni. Riv. Period. Lav. Accad. Sci. Lett. Arti Padova **1(3)**: 237-271.

Trevisan V. 1853b. Caratteri di dodici nuovi generi di licheni. Padova.

Trevisan V. 1853c. Spighe e Paglie. Padova.

Trevisan V. 1856. *Brigantiaea* novum lichenum genus. Linnaea **28**: 283-298.

White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. Bull. Br. Lichen Soc. 57 (Suppl.): 1-41.

MYCOTAXON

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Notes on *Chlorociboria* (*Helotiales, Ascomycota*) in Southern Brazil

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Abstract — *Chlorociboria* is an ascomycete genus easy to identify in field due its peculiar characteristics: the mycelium of some species produces a blue-green staining on decaying wood. However, no collections of the genus had previously been deposited in Herbarium FLOR (State of Santa Catarina). Since 2006, three *Chlorociboria* specimens from the State of Santa Catarina and one specimen from the State of Rio Grande do Sul were identified and deposited in FLOR. *C. aeruginosa* and *C. aeruginascens* are the first reports from Santa Catarina, while *C. aeruginascens* represents the first record from Rio Grande do Sul.

Key words — discomycete, taxonomy, Brazilian mycobiota

Introduction

Chlorociboria Seaver ex C.S. Ramamurthi et al. species are easily recognized in field because the mycelium of all species produces a blue-green staining on decaying wood due the presence of xylindein, a peri-hydroxy-quinone compound (Blackburn et al. 1965). The genus was erected to group discomycete species with apothecia green or olivaceous, stipitate or substipitate, up to 2 cm diam, asci 8-spored, ascospores irregulary ellipsoid to vermiform, simple and hyaline (Seaver 1936). Seaver (1936) failed to provide a Latin diagnosis, and the genus was later validated by Ramamurthi et al. (1958). Seaver designated *Chlorociboria aeruginosa* as type species, with two additional species: *C. versiformis* (Pers.) Seaver ex C.S. Ramamurthi et al. and *C. strobilina* (Alb. & Schwein.) Seaver, nom. inval.

Ramamurthi et al. (1958) reported five species from North America: C. *aeruginascens* (Nyl.) Kanouse ex C.S. Ramamurthi et al., *C. aeruginosa, C. rugipes* (Peck) C.S. Ramamurthi & Korf, *C. versiformis* and *C. bulgarioides* (Rabenh.) C.S. Ramamurthi et al. Dennis (1960) accepted four British species: *C. aeruginascens*, *C. aeruginosa*, *C. versiformis* and *C. aeruginella* (P. Karst.) Dennis ex C.S. Ramamurthi et al.

Later Dixon (1975) recognized only four species of *Chlorociboria* in his monograph of the genus: *C. aeruginosa*, *C. aeruginascens* (with two subspecies), *C. argentinensis* J.R. Dixon and *C. omnivirens* (Berk.) J.R. Dixon. He excluded the following species: *C. aeruginella*, *C. bulgarioides*, *C. musae* Dennis, *C. rugipes*, *C. strobilina* and *C. versiformis*.

Despite the originally few species described in the genus, recently thirteen new species were described from New Zealand, suggesting a possible Asian/Australasian centre of diversity (Johnston & Park 2005).

Chlorociboria aeruginascens has been previously reported from Southern Brazil in Paraná (Meijer 2006) and *C. aeruginosa* was already reported from Rio Grande do Sul (Dixon 1975, Guerrero & Homrich 1999).

Until 2006, no specimens of *Chlorociboria* were deposited in Herbarium FLOR (BOT/CCB/UFSC), State of Santa Catarina, Southern Brazil. The Laboratory of Mycology at the Federal University of Santa Catarina was established in 1983 with emphasis in studies on poroid basidiomycetes. No recent work on ascomycetes has been published in the State.

Materials and methods

The Southern Region of Brazil includes the States of Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS) and covers 576,300.8 km^2. It borders Uruguay, Argentina, Paraguay, Brazilian Center-West and Southeast Regions and the Atlantic Ocean. The climate is temperate in almost the entire region, although the northeast part of the region has a tropical climate.

A few *Chlorociboria* specimens have been collected in SC since 2006. One specimen collected in Caxias do Sul (RS) in 2006 is also included in this article.

The material was analyzed macro- and micromorphologically and drawings were made with a camera lucida. Microscopic characters were examined and measured using light microscopy, in mounts of 1% KOH + 1% aqueous solution of phloxine and Melzer's iodine reagent. The number of ascospores and asci measured to form the size ranges in the description are 20 and 10, respectively. Specimens were identified using specialized literature and are now preserved in Herbarium FLOR (Holmgren & Holmgren 1998).

Descriptions, taxonomic remarks and camera lucida drawings of the collected species are presented in this article. Also a key to *Chlorociboria* species and subspecies found in South America is provided.

Results

A total of four *Chlorociboria* specimens were collected and identified as *C. aeruginascens* and *C. aeruginosa*. The specimens were found on fallen decaying wood that was blue-green stained.

Two specimens of *C. aeruginascens* were collected in SC, while one specimen of this species was collected in RS. One specimen of *C. aeruginosa* was collected in SC.

Descriptions

Chlorociboria aeruginascens* subsp. *brasiliensis (Berk. & Cooke) J.R. Dixon, Mycotaxon 1: 213 (1975) **Figure 1**

Apothecia solitary to gregarious, stipitate, disc-shaped, disc dark bluish green to bluish green, up to 3 mm diam., hymenium light bluish green, stipe slightly eccentric to eccentric, dark bluish green, about 4 mm long. Asci clavate, wall thicked at apex, 40–55 × 4–5 μm, 8-spored, spores irregularly crowded. Ascospores unicellular, cylindric to fusoid, often slightly curved in side view, thin-walled, hyaline, smooth, 4–5 × 1–2 μm, with oil droplets. Paraphyses filiform, septate. Tomentum hyphae coiled, with rounded apex, slightly thick-walled, hyaline, smooth, up to 2 μm diam. Mycelium causes blue-green staining on wood.

SUBSTRATE — dead hardwood not identified.

DISTRIBUTION — tropical South America (Dixon 1975).

SPECIMENS EXAMINED — BRAZIL. **RIO GRANDE DO SUL: Caxias do Sul**. col. Trierveiler-Pereira & Baltazar. 01.V.2006 (*FLOR 31891*). BRAZIL. **SANTA CATARINA: Santo Amaro da Imperatriz**. Vargem do Braço. Parque Estadual Serra do Tabuleiro. col. Trierveiler-Pereira & Bekai. 12.XI.2006 (*FLOR 31910*). BRAZIL. **SANTA CATARINA: Alfredo Wagner**. RPPN Rio das Furnas. col. Trierveiler-Pereira, Baltazar & Gerlach. 02.IX.2007 (*FLOR 31912*).

TAXONOMIC REMARKS — *C. aeruginascens* subsp. *brasiliensis* is distinguished from *C. aeruginascens* subsp. *aeruginascens* by its smaller ascospores, 3–5.5(–6) × 1–1.5 μm versus 5–7(–10) × 1–1.5(–2.5) μm, and shorter asci, (35–)41–49 μm versus (40–)50–65(–75) μm (Dixon 1975). This subspecies had previously been reported only from tropical South America (Dixon 1975). The recently described *C. aeruginascens* subsp. *australis* P.R. Johnst., known only from New Zealand, is morphologically indistinguishable from *C. aeruginascens* subsp. *aeruginascens*, but has distinct ITS sequences (Johnston & Park 2005).

Another South American species, *C. argentinensis*, is also similar but has larger ascospores, blackish aeruginous hymenium on dry material, and lacks the tomentum hyphae of *C. aeruginascens* (Dixon 1975).

Chlorociboria aeruginosa (Pers.) Seaver ex C.S. Ramamurthi, Korf & L.R. Batra, Mycologia 49(6): 859 (1958 ['1957']) **Figure 2**

Apothecia solitary, stipitate to subssessile, cup-shaped to disc-shaped, disc dark bluish green to light green, up to 2 mm diam., hymenium yellowish green, stipe central or slightly eccentric, dark bluish green, about 1 mm long. Asci clavate, wall thicked at apex, up to 70 × 5 μm, 8-spored, spores irregularly crowded. Ascospores unicellular, cylindric to fusoid, often slightly curved in side view, thin-walled, hyaline, smooth, 10–14 × 3–4 μm, with oil droplets. Paraphyses filiform, septate, up to 1.5 μm diam. Tomentum hyphae straight to coiled, with rounded apex, slightly thick-walled to thick-walled, hyaline, wall roughened, up to 3 μm diam. Mycelium causes blue-green staining on wood.

SUBSTRATE — dead hardwood not identified.

DISTRIBUTION — America and few collections in Russia and Asian countries (Dixon 1975).

SPECIMEN EXAMINED — **BRAZIL. SANTA CATARINA: Urubici**. Morro da Igreja. col. Trierveiler-Pereira. 02.XII.2006 (*FLOR 31892*).

TAXONOMIC REMARKS — Since *C. aeruginosa* and *C. aeruginascens* are frequent in America and sometimes macroscopically similar, both species have been erroneously identified, especially by amateur mycologists using field guides. Ramamurthi et al. (1958) noticed that *C. aeruginosa* not only has larger ascospores but the tomentum hyphae are strongly roughened with crystals. The hymenium of our material is yellowish, one characteristic used by Dennis (1960) to differentiate it from *C. aeruginascens*.

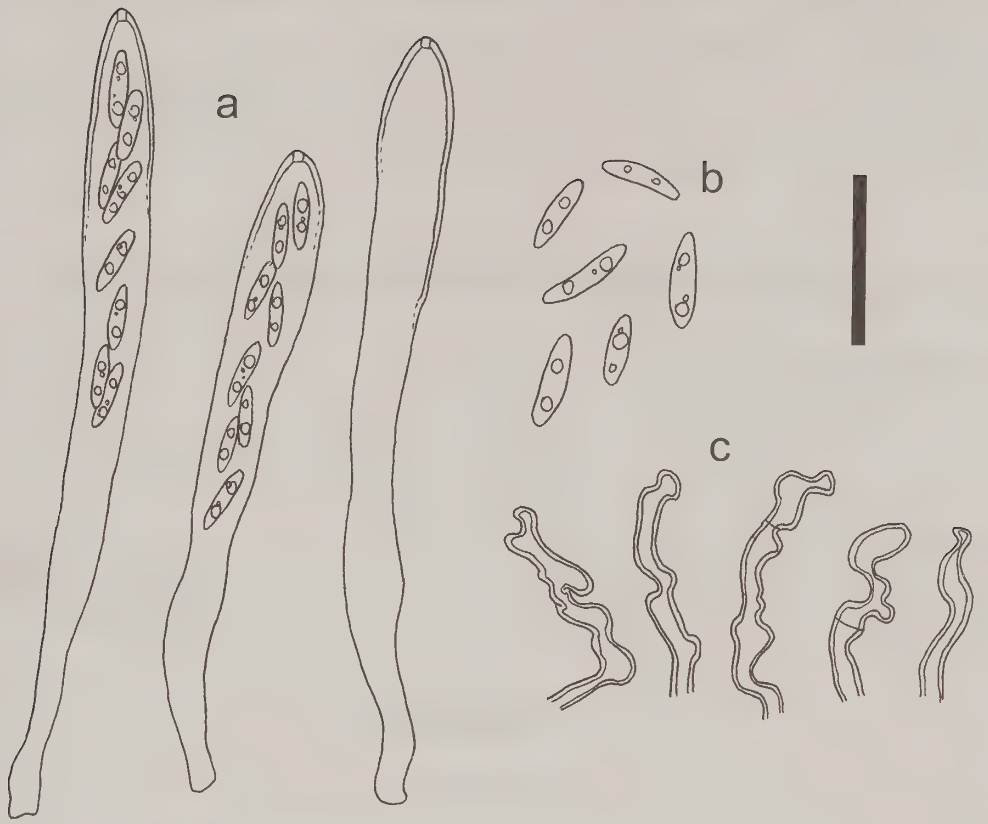
Discussion

The identification of *Chlorociboria* species was traditionally based in gross morphology, ascospores, asci and paraphyses (Dixon 1974), however, Ramamurthi et al. (1958) noticed the importance of tomentum hyphae in species differentiation. Following Guerrero & Silveira (2003), tomentum is an external covering of delicate, short and flexible hairs.

The two *Chlorociboria* species described in this article represent new records for Santa Catarina and *C. aeruginascens* represents the first record from Rio Grande do Sul.

Although only a small number of *Chlorociboria* specimens were available, these results might indicate a low diversity for the genus in Brazil. Gamundí

1



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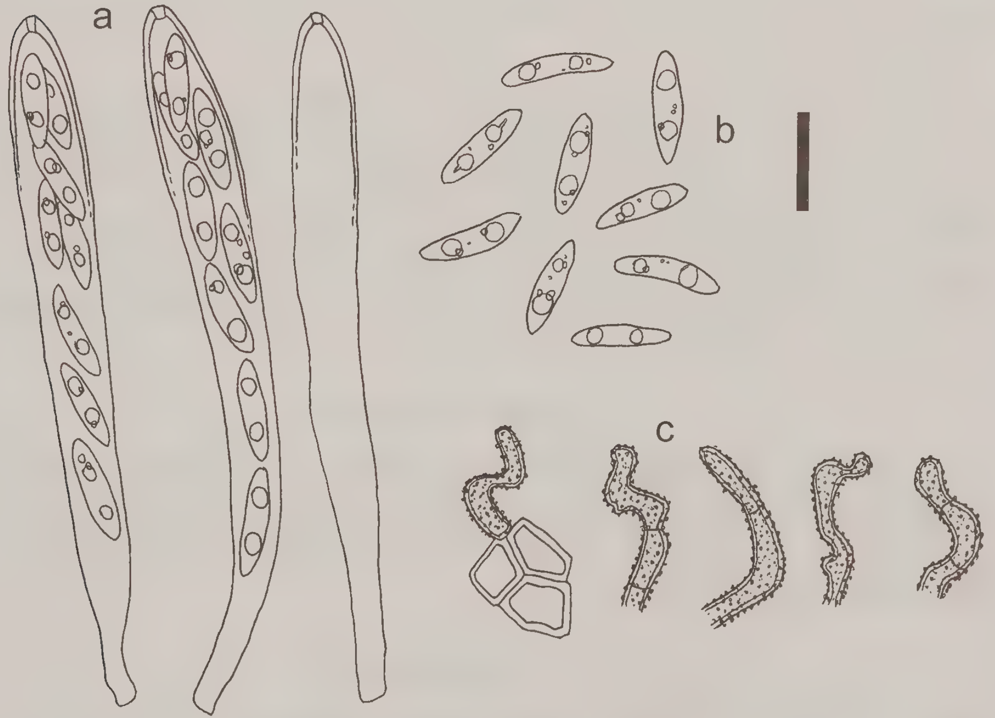

Figures 1-2. 1. ***Chlorociboria aeruginascens*** **subsp.** ***brasiliensis*****.** a: asci, b: ascospores, c: tomentum hyphae (scale bar = 10 µm). **2.** ***Chlorociboria aeruginosa*****.** a: asci, b: ascospores, c: tomentum hyphae (scale bar = 10 µm).

(1962) and Gamundí & Romero (1998) also reported few *Chlorociboria* species from Neuquén, Río Negro and Tierra del Fuego, Argentina.

The species and subspecies so far recorded from South America are: *C. aeruginosa*, *C. aeruginascens* subsp. *aeruginascens*, *C. aeruginascens* subsp. *brasiliensis* and *C. argentinensis* (Dixon 1975).

Key to *Chlorociboria* species and subspecies in South America

1a. Tomentum hyphae absent . . . . *C. argentinensis*
1b. Tomentum hyphae present 2

2a. Tomentum hyphae strongly roughened with crystals, ascospores
10–14 × 3–4 µm . . . . *C. aeruginosa*
2b. Tomentum hyphae smooth, ascospores smaller 3

3a. Ascospores 5–7 × 1–1.5 µm . . . . *C. aeruginascens* subsp. *aeruginascens*
3b. Ascospores 3–5.5 × 1–1.5 µm . . . . *C. aeruginascens* subsp. *brasiliensis*

Conclusions

Herbarium FLOR has approximately 4,000 fungal collections, of which only 1.5% (60 specimens) represent *Ascomycota*. Similar results were reported by Meijer (2006) in the State of Paraná: from a preliminary list of fungi, only about 10% were ascomycetes.

These numbers reflect the necessity of research and publications targeting the ascomycetes in Southern Brazil. Since many of Santa Catarina's ascomycetes were collected and preserved by Europeans in other herbaria around the world, and published in local journals, it is difficult to estimate the number of ascomycete species recorded from the State. More collecting must be done to improve the herbarium collection and increase knowledge of the group.

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Literature cited

Blackburn GM, Ekong DEU, Nielson AH, Lord Todd. 1965. Xylindein. Chimia 19: 208–212.

Dennis RWG. 1960. British cup fungi and their allies. An introduction to the ascomycetes. The Ray Society by Quaritch: London (England). 280 pp.

Dixon JR. 1974. *Chlorosplenium* and its segregates. I. Introduction and the genus *Chlorosplenium*. Mycotaxon 1: 65–104.

Dixon JR. 1975. *Chlorosplenium* and its segregates. II. The genera *Chlorociboria* and *Chlorencoelia*. Mycotaxon 1: 193–237.

Gamundí IJ. 1962. Discomycetes inoperculados del Parque Nacional Nahuel Huapí (Argentina). Darwiniana 12(3): 385–445.

Gamundí IJ, Romero AI. 1998. *Fungi, Ascomycetes Helotiales: Helotiaceae*. Fl. Criptog. Tierra del Fuego 10(5): 1–131.

Guerrero RT, Homrich MH. 1999. Fungos Macroscópicos Comuns no Rio Grande do Sul. Guia para identificação.Ed. Universidade/UFRGS: Porto Alegre (Brasil). 124 pp.

Guerrero RT, Silveira RMB. 2003. Glossário ilustrado de fungos. Termos e conceitos aplicados à Micologia: Ed. Universidade/UFRGS: Porto Alegre (Brasil). 102 pp.

Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>.

Johnston PR, Park D. 2005. *Chlorociboria* (*Fungi, Helotiales*) in New Zealand. New Zealand J. Bot. 43: 679–719.

Meijer AAR. 2006. Preliminary list of the macromycetes from the Brazilian State of Paraná. Bol. Mus. Bot. Mun. 68: 3–55.

Ramamurthi CS, Korf RP, Batra LR. 1958. A revision of the North American species of *Chlorociboria* (*Sclerotiniaceae*). Mycologia 49: 854–863.

Seaver FJ. 1936. Photographs and descriptions of cup-fungi-XXIV. *Chlorociboria*. Mycologia 28: 390–394.

MYCOTAXON

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Myxomycetes of Sonora, Mexico. 5: Ajos-Bavispe National Forest Reserve and Wildlife Refuge and Sierra de Alamos-Rio Cuchujaqui Biosphere Reserve

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Abstract — One hundred and fifty-three collections of myxomycetes from the protected areas Ajos - Bavispe and Sierra de Alamos - Rio Cuchujaqui, located in Sonora, Mexico, were studied. Fifty-one taxa were determined, and sixteen of these are new records for the Mexican state of Sonora (*Comatricha anomala, C. meandrispora, Cribraria tenella, Diderma acanthosporum, D. rugosum, Didymium nigripes, Hemitrichia foliicola, Leocarpus fragilis, Licea testudinacea, Macbrideola lamprodermoides, Physarum echinosporum, Stemonaria irregularis, Stemonitis axifera, Stemonitopsis typhina, Trichia lutescens* and *T. varia*) are new records for the Mexican state of Sonora: Four of these (*Comatricha meandrispora, Licea testudinacea, Physarum echinosporum* and *Stemonaria irregularis*) are new records for the Mexican myxobiota, and *Comatricha meandrispora* is recorded for the first time from the American continent.

Key words — *Myxomycota*, chorology, taxonomy, SEM

Introduction

The fifth contribution to the knowledge of the myxomycetes of Sonora, Mexico, specifically the fourth of the Ajos - Bavispe National Forest Reserve and Wildlife Refuge (ABNF) and Sierra de Alamos - Rio Cuchujaqui Biosphere Reserve (ACBR), a series that was initiated by Moreno et al. (2006a) and Lizárraga et al. (2007, 2008), is presented. Including the fifteen new records reported herein, there are now 96 taxa of myxomycetes known for Sonora, with 48 and 33 recorded for ABNF and ACBR, respectively.

There are 151 priority regions for conservation of biodiversity in Mexico, and 19 of them are located in Sonora (CONANP 2003). The ABNF was the first protected area in Sonora, and its high biodiversity is due to an elevational gradient. It is located in the convergence of the Nearctic and Neotropical regions (Guerra 1998). For ABNF, 1,234 species of vascular plants have been recorded; seven and nine of them are known only for Mexico and Sonora respectively. *Acer grandidentatum* Nutt., *Pseudotsuga menziesii* (Mirb.) Franco, *Quercus gambelii* Nutt. and *Juglans major* (Torr.) A. Heller are representative of this zone.

The ACBR is one of five protected areas with a management plan in Sonora. It has a biological richness of approximately 1,100 plant species classified in 148 families; this total represents 67% of all the plant families known for Mexico. Located in the transitional zone between the Nearctic and Neotropical regions, the ACBR is near the northern limits of tropical dry forest and the distribution of several species. ACBR is characterized by the high richness and diversity of its flora and fauna, with both tropical and temperate affinities; as well as variety of climates, soils, geological formations, types of vegetation and accidental topography. *Cedrela odorata* L., *Ceiba acuminata* Rose, *Haematoxylon brasiletto* H. Karst., *Ipomoea arborescens* (Humb. & Bonpl. ex Willd.) G. Don, *Randia echinocarpa* Sessé & Moc. ex DC. and *Taxodium mucronatum* Ten. are some of the more characteristic species of ACBR.

Materials and methods

The specimens studied were collected mainly in the field from 2005 to 2007. Some were cultivated in moist chamber cultures, which made it possible to study interesting species as *Comatricha elegans* and *C. meandrispora*. Collections are kept in the herbarium of the Centro de Estudios Superiores del Estado de Sonora, Hermosillo, Sonora, Mexico (CESUES) and Dpto. Biología Vegetal, University of Alcalá de Henares, Spain (AH), as indicated for each studied collection. Samples for light microscopy were mounted in absolute ethyl alcohol and then in Hoyer's medium after evaporation of the alcohol. Spore measurements were made with an oil immersion objective and included surface structures such as spines or warts.

Collections kept in AH have been studied by scanning electron microscopy (SEM), applying the critical point drying and sputtering with gold-palladium. For ultramicroscopic studies, the material to be examined was rehydrated in concentrated ammonium hydroxide (28–30%) for 30 minutes, dehydrated in aqueous ethanol (70%) for 30 minutes, fixed for 2 hours in pure ethylene glycol dimethyl ether (= 1,2-dimethoxymethane) and finally immersed in pure acetone for at least 2 hours. The micrographs were taken at the University of Alcalá using a Zeiss DSM-950. This technique uses very little material (one sporocarp, a part of it or only a small portion of spores). Terminology used to describe spore ornamentation follows that of Rammeloo (1975a,b).

Table 1. Sampling localities in the protected areas Ajos - Bavispe and Sierra de Alamos - Rio Cuchujaqui.

LOCALITIES	N	W	ELEVATION	VEGETATION
MUNICIPALITY OF CANANEA				
1. El Campamento	30°58'22"	109°57'38"	1997 m	POGF
MUNICIPALITY OF BACOACHI				
2. El Manzano	30°56"04"	109°57'58"	2218 m	POF
MUNICIPALITY OF FRONTERAS				
3. El Frijolito	30°56'35"	109°57'21"	2286 m	POF
4. La Sal	30°57'22"	109°56'55"	1936 m	GF
5. La Valdeza	30°38'06"	109°47'22"	1546 m	OOF
MUNICIPALITY OF CUMPAS				
6. La Antena	30°00'55"	109°32'36"	2005 m	POF
7. El Encinal	30°00'02"	109°33'29"	1653 m	OF
8. La Selva	29°57'41"	109°36'55"	881 m	SS
9. El Mezquital	29°57'26"	109°38'23"	882 m	M
MUNICIPALITY OF ALAMOS				
10. Huerta Vieja	27°02'05"	109°02'54"	563 m	TDF
11. Promontorios	27°00'53"	109°02'11"	536 m	TDF
12. El Aguaje	26°56"49"	108°41'41"	491 m	TDSF, GF
13. El Platanar	26°59'27"	108°40'40"	635 m	TDSF
14. La Cañita	26°59'31"	108°38'59"	643 m	TDF, OF
15. Mesa del Trigo	26°58'13"	108°41'19"	583 m	TDSF/SVSH
16. El Cuzalito	26°58'33"	108°39'33"	713 m	OF
17. San Pedro	27°03'53"	108°43'44"	444 m	TDF
18. Palo Injerto	27°03'04"	108°43'52"	399 m	TDF/SVS

VEGETATION TYPES: Pine-Oak Gallery Forest (POGF); Pine-Oak Forest (POF); Gallery Forest (GF); Oak Open Forest (OOF); Oak Forest (OF); Subtropical Scrub (SS); Mezquital (M); Tropical Deciduous Forest (TDF); Tropical Deciduous and Subdeciduous Forest (TDSF); Secondary Vegetation of Shrubs and Herbs (SVSH); Secondary Vegetation of Shrubs (SVS).

The information provided for each species includes its locality according to Table 1; names of collectors are abbreviated: A. Bautista (AB), J. Cifuentes (JC), M. Coronado (MC), S. Chacón (SC), M. Esqueda (ME), S. Gómez (SG), M. Lizárraga (ML), E. Pérez-Silva (EPS), M. Rivera (MR), A. Sánchez (AS) and R. Valenzuela (RV); date and herbarium. First records for Sonora, Mexico or the American continent are indicated by one, two or three asterisks, respectively. For the distribution of species in Mexico, we follow the contribution of Moreno et al. (2007). When a species has been cited for more than 15 Mexican states, we consider it as amply reported throughout Mexico.

Species List

Arcyria cinerea (Bull.) Pers., Syn. Meth. Fung.: 184 (1801)

> Specimens studied: Locality 3, leg. ML & AB, 28.VIII.2007, on *Quercus emoryi* Torr. wood, *CESUES 7678*. It was cultivated in a moist chamber (18.X.2007), fruiting on 22.X.2007. Locality 8, leg. ML & AB, 27.VIII.2005, on the decayed wood of *Ipomoea arborescens*, *CESUES 7581*. Locality 16, leg. ML & AB, 15.IX.2006, *CESUES 7632*. Locality 17, Ibidem, 16.IX.2006, on dried *Randia echinocarpa* fruits, *CESUES 7660*.

Observations: This species has been widely cited for localities throughout Mexico.

Arcyria denudata (L.) Wettst., Verh. Zool.-Bot. Ges. Wien 35: Abh. 535 (1886)

> Specimens studied: Locality 1, leg. ML & AB, 24.VIII.2005, on decayed wood, *CESUES 7564*, *CESUES 7585*. Locality 4, leg. ML, MR, SC & AS, 28.VIII.2007, on the decayed wood of *Quercus* sp., *CESUES 7679*. Locality 10, leg. ML, ME, SC, RV & JC, 12.IX.2006, *CESUES 7591*. Locality 11, Ibidem, *CESUES 7592*, *CESUES 7593*. Locality 16, Ibidem, 15.IX.2006, *CESUES 7633*, *CESUES 7634*, *CESUES 7635*. Locality 17, leg. ML, AB, AS & MR, 24.XI.2005, *CESUES 7588*. Locality 18, leg. ML & AB, 13.IX.2006, *CESUES 7600*.

Observations: This is another species that has been widely cited for localities throughout Mexico.

Ceratiomyxa fruticulosa (O.F. Müll.) T. Macbr., N. Amer. Slime-Moulds: 18 (1899)

> Specimens studied: Locality 18, leg. ML, ME, SC, RV & JC, 14.IX.2006, on decayed wood, *CESUES 7616*.

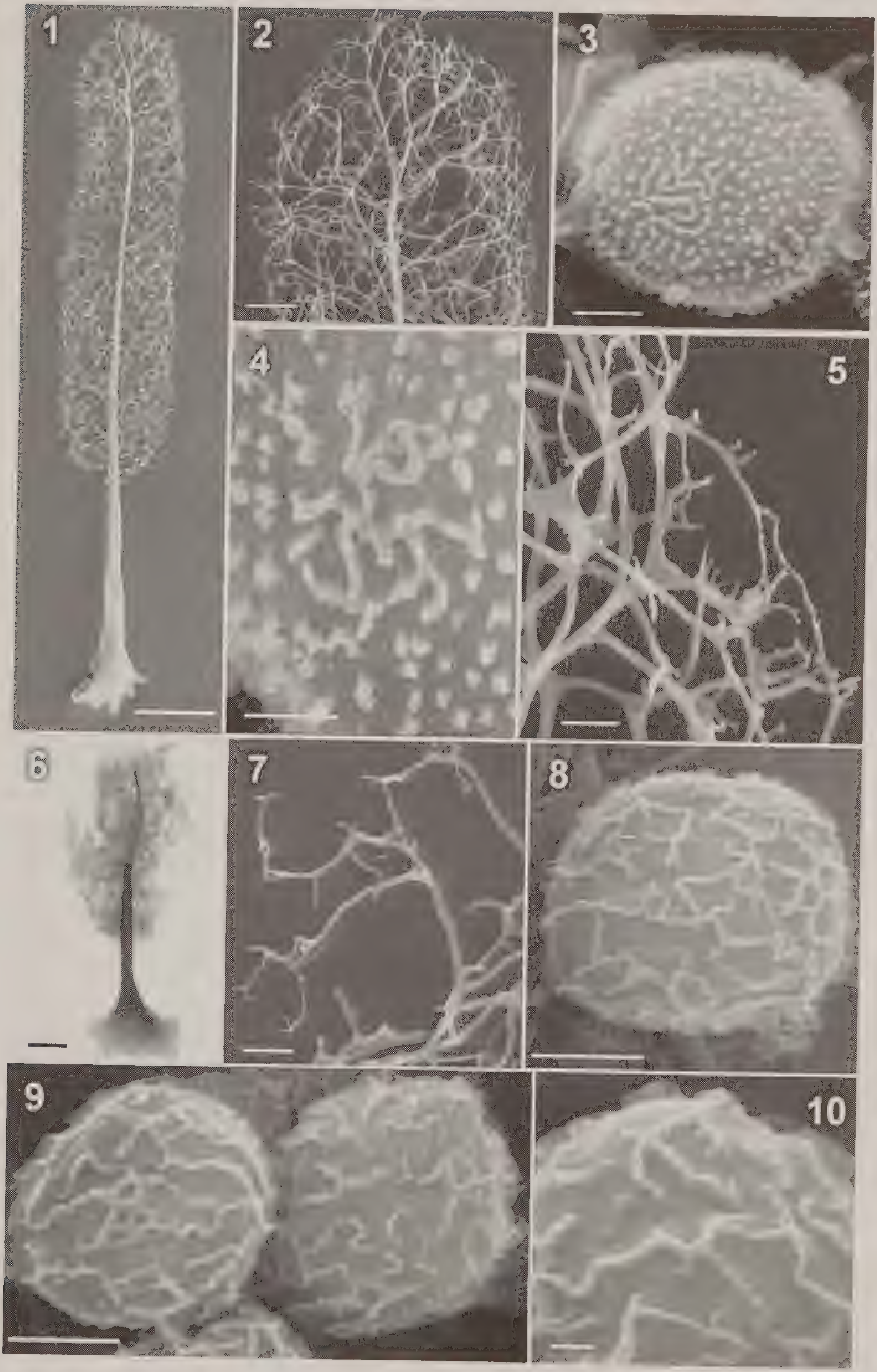
Observations: This species has been amply cited for Mexico.

Comatricha anomala Rammeloo,
Bull. Jard. Bot. Belg. 46(1–2): 237 (1976) **Figs. 1–5**

> Specimens studied: Locality 1, leg. ML, MR, SC & AS, 28.VIII.2007, on decayed wood of *Quercus* sp., *CESUES 7680* in *AH 31958*.

Observations: This species is characterized by a cylindrical sporotheca, with a columella reaching to the apex of the sporotheca, a capillitium forming a net with short free ends and globose spores, 8–10 µm, verruculose and with small areas of complete or incomplete reticulum. It has been previously reported in Mexico for Baja California (Lizárraga et al. 1997, 2004a) and Chihuahua (Lizárraga et al. 2005a) but our record is the first for the Sonoran myxobiota.

Figs. 1–10 *Comatricha anomala AH* 31958: 1. Sporotheca. 2. Detail of sporocarp apex. 3. Spore. 4. Detail of spore ornamentation. 5. Detail of capillitium. Figs. 6–10 *Comatricha meandrispora AH* 31959: 6. Sporotheca. 7. Detail of capillitium. 8–9. Spores. 10. Detail of spore ornamentation.
Scale bars. 1 = 20 µm. 2 = 50 µm. 3 = 2 µm. 4 = 1 µm. 5 = 10 µm.
6 = 0.1 mm. 7 = 10 µm. 8–9 = 2 µm. 10 = 0.5 µm.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Comatricha elegans (Racib.) G. Lister, Guide Brit. Mycetozoa, ed. 3: 31 (1909)

Specimens studied: Locality 17, leg. ML, AS, MR & SG, 24.XI.2005, growing on *Pseudotsuga menziesii* wood, *CESUES 7589*. It was cultivated in a moist chamber (24. II.2006), fruiting on 9.III.2006.

Observations: This species was described recently for Chihuahua by Lizárraga et al. (2005b), who provided photomicrographs that show sporocarps and spore ornamentation under SEM. In Mexico, it is known from Chihuahua, Jalisco, Sonora, Tabasco, and Veracruz.

*****Comatricha meandrispora*** A. Castillo, G. Moreno & Illana, Mycotaxon 46: 315. 1993 **Figs. 6–10**

Specimens studied: Locality 11, leg. ML, ME, SC, RV & JC, on decayed wood, slide *CESUES 7590* in *AH 31959*, It was cultivated in a moist chamber (7.IX.2006), fruiting on 12.IX.2006.

Observations: The collection studied is characterized by stalked sporocarps, that occur in a group of three, 1 mm total height. Sporotheca 0.7 mm long, cylindrical, 0.3 mm diam. Peridium evanescent. Columella attenuating to the apex. Stalk dark violet, 0.3 mm long, thick, fibrous at the base. Hypothallus not observed. Capillitial threads violet-brown, 1–3 μm thick, fibrous at the base. Spores globose to subglobose, 5–6(-7) μm, with spinulose ornamentation, seemingly ornamented by an incomplete reticulation that is distinct by TL.

Comatricha meandrispora is a new record for the entire American continent. We consider the previous records of this species as *C. meandrispora* cf. from Brazil (Mobin & Cavalcanti 1999) as doubtful, because the authors reported the spore size as larger than 7.6 μm diam. and the epispore to be faintly spinulose, which is quite different from that of *C. meandrispora*. Moreover, the authors confused the record of Castillo et al. (1993) from Guadalajara (Spain) with Guadalajara (Mexico). More recently, Castillo et al. (2005) published colour pictures of sporocarps and sporotheca, as well as spore ornamentation under SEM based on new collections gathered from several localities in Spain.

Comatricha pulchella (C. Bab.) Rostaf., Sluzowce Monogr. Suppl.: 27 (1876)

Specimens studied: Locality 1, leg. ML & AB, 24.VIII.2005, growing on *Acer grandidentatum* and *Quercus* sp. leaves and stems, *CESUES 7565*. Locality 5, Ibidem, 25.VIII.2005, on *Quercus* sp. leaves, *CESUES 7575*. Locality 6, Ibidem, *CESUES 7576*.

Observations: This species was cited previously for Chihuahua, Jalisco, Oaxaca, Quintana Roo, Sonora, Veracruz, and Yucatan.

Comatricha tenerrima (M.A. Curtis) G. Lister, Guide Brit. Mycetozoa, ed. 4: 39 (1919)

Specimens studied: Locality 11, leg. ML, ME, SC, RV & JC, 12.IX.2006, on decayed wood, *CESUES 7594*.

Observations: This species was reported previously for Baja California, Chihuahua, Guerrero, Jalisco, Quintana Roo, Sonora, Tlaxcala, Veracruz, and Yucatan.

Craterium leucocephalum (Pers. ex J.F. Gmel.) Ditmar, in Sturm, Deutschl. Fl. Pilze 1(1): 21 (1813)

Specimens studied: Locality 3, leg. ML, MR, SC & AS, 27.VIII.2007, growing on dried *Quercus* sp. leaves, *CESUES 7676*. Locality 12, leg. ML, ME, SC, RV & JC, 14.IX.2006, *CESUES 7617*. Locality 16, Ibidem, 15.IX.2006, *CESUES 7636*, *CESUES 7637*. Locality 18, Ibidem, 13.IX.2006, growing on *Quercus* sp. leaves, *CESUES 7601*.

Observations: *Craterium leucocephalum* was cited previously for Baja California Sur, Chiapas, Chihuahua, Jalisco, Morelos, Nuevo Leon, Queretaro, Quintana Roo, Tabasco, Sonora, Veracruz, and Yucatan.

Craterium obovatum Peck, Bull. Buffalo Soc. Nat. Sci. 1: 64 (1873)
≡ *Badhamia obovata* (Peck) S.J. Sm., in Martin, Brittonia 13: 112 (1961)

Specimens studied: Locality 1, leg. ML, MR, SC & AS, 29.VIII.007, on dried *Quercus* sp. leaves, *CESUES 7697*. Locality 5, leg. ML & AB, 25.VIII.2005, on dried *Quercus* sp. leaves, *CESUES 7577*, *CESUES 7578*. Locality 16, leg. ML, ME, SC, RV & JC, 14.IX.2006, on dried *Quercus* sp. leaves, *CESUES 7618*, *CESUES 7619*, *CESUES 7620*, *CESUES 7621*.

Observations: This foliicolous species was described recently by Lizárraga et al. (2007). The authors published SEM photomicrographs of its typical spore ornamentation. This species is an uncommon element of the Mexican myxobiota and is known from Baja California, Sonora, and Veracruz.

Craterium paraguayense (Speg.) G. Lister, in Lister, Monogr. Mycetozoa, ed. 2: 95 (1911)

Specimens studied: Locality 5, leg. ML, MR, SC & AS, 29.VIII.2007, on dried *Quercus* sp. leaves, *CESUES 7698*.

Observations: A detailed study of this species and its separation from *Physarum newtonii* T. Macbr., based on the holotypus and the spore ornamentation by SEM, was carried out by Castillo et al. (2002). This species appears to be relatively uncommon in Mexico, but it is known from Chihuahua, Sonora, Tlaxcala, Veracruz, and Yucatan.

*****Cribraria tenella*** Schrad., Nov. Gen. Pl.: 6 (1797)

Specimens studied: Locality 2, leg. ML & AB, 24.VIII.2005, *CESUES 7566* in *AH 31967*. Locality 4, Ibidem, 23.VIII.2007, on decayed wood, *CESUES 7661*.

Observations: The characteristic features of this species are the stalked sporocarps, light yellowish brown with olivaceous hues, and 1.3–1.8 mm total height. Sporotheca subglobose, 0.3–0.5 mm diam. Peridium single, remaining intact in only the lower 1/3 portion as a calyculus. Peridial net more or less isodiametric, lax, with thicker nodes of calcic granules, 1–2 µm diam. Stalk 0.9–1.2 mm total height, cylindrical, deep reddish brown. Spores 6–7 µm diam., globose, verrucose, with a lipid guttule. Under SEM, spore ornamentation is observed as short baculate, with the individual portions sometimes joined in short crests. It is cited for the Mexican states of Jalisco, Quintana Roo, Veracruz, and Yucatan.

Cribraria violacea Rex, Proc. Acad. Nat. Sci. Philadelphia 43: 393 (1891)

Specimens studied: Locality 16, leg. ML, ME, SC, RV & JC, 15.IX.2006, on decayed wood (next to *Metatrichia horrida*), *CESUES 7638*.

Observations: This species has been amply reported for Mexico.

Diachea leucopodia (Bull.) Rostaf., Sluzowce Monogr.: 190 (1874)

Specimens studied: Locality 1, leg. ML, MR, SC & AS, 27.VIII.2007, on decayed *Quercus* sp. leaves, *CESUES 7677*.

Observations: *Diachea leucopodia* has been recorded for Baja California, Chihuahua, Estado de Mexico, Jalisco, Morelos, Nuevo Leon, Sinaloa, Sonora, Tlaxcala, and Veracruz.

Dictydiaethalium plumbeum (Schumach.) Rostaf., in Lister, Monogr. Mycetozoa: 157 (1894)

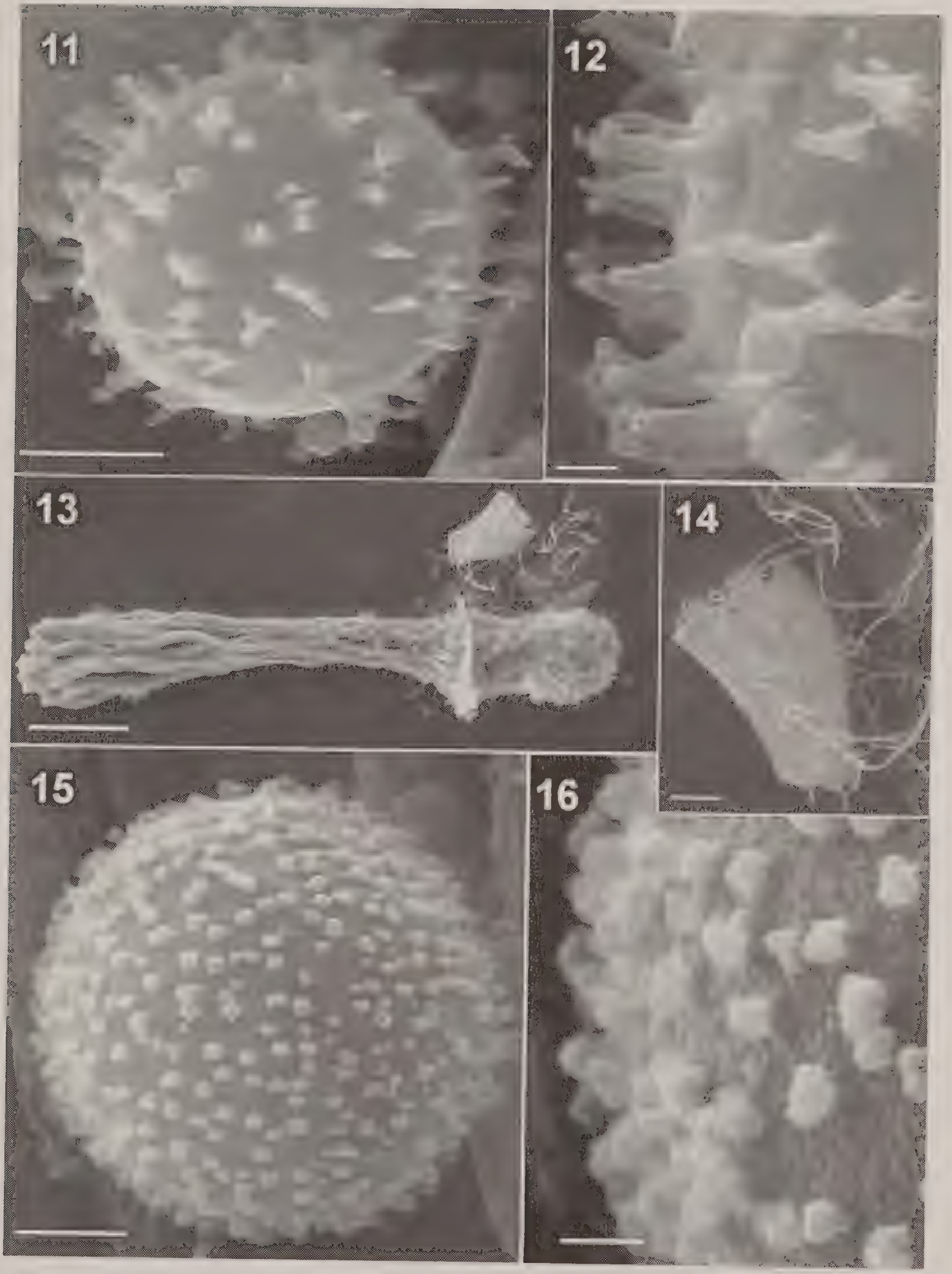
Specimens studied: Locality 7, leg. ML, MR, SC & AS, 30.VIII.2007, on decayed *Quercus* sp. wood, *CESUES 7703*. Locality 18, leg. ML, ME, SC, RV & JC, 13.IX.2006, on decayed wood, *CESUES 7602*.

Observations: This species has been recorded previously for Baja California, Chihuahua, Nuevo Leon, Queretaro, Sinaloa, Sonora, and Veracruz.

***Diderma acanthosporum** Estrada & Lado, in Estrada-Torres et al., Mycologia 93(4): 748 (2001) **Figs. 11–12**

Specimens studied: Locality 11, leg. EPS, ML, ME, AS & MR, 21.IX.2005, on decayed wood, *CESUES 7267* in *AH 31969*. Locality 12, leg. ML, ME, SC, RV & JC, 13.IX.2006, growing on dried *Quercus* sp. leaves, *CESUES 7296* in *AH 31907*. Locality 18, Ibidem, on decayed *Quercus* sp. wood, *CESUES 7292*.

Observations: This species is recognized by its pseudoaethalioid fructifications; stalked sporocarps; flat sporothecae; double peridium; thick, calcareous, crustose, pink to whitish external peridial layer and with the inner layer, membranous, brownish; capillitial tubes 1–2.5 µm diam., branched, forming a net, greyish brown; and by its large spores of 14–18 µm diam., black in mass and dark with a less dark zones by TL, ornamented with large spines. In SEM, the



Figs. 11–16 *Diderma acanthosporum AH* 31969: 11. Spore. 12. Detail of spore ornamentation. Figs. 13–16: *Diderma rugosum AH* 31960: 13. Detail of stalk and columella. 14. Detail of a peridial plate and capillitium. 15. Spore. 16. Detail of spore ornamentation.

Scale bars. 11 = 5 µm. 12 = 1 µm. 13 = 100 µm. 14 = 20 µm. 15 = 2 µm. 16 = 0.5 µm.

spore ornamentation is irregularly distributed conformed by conspicuous spines "equinulated" with an apex that is occasionally dichotomously branched. *Diderma acanthosporum* was described recently by Estrada-Torres et al. (2001) for the Central Region of Mexico (Morelos and Estado de Mexico). The new recollections were provided by the ACBR, Sonora. Species chorology was significantly increased in the Northwest of Mexico.

***Diderma rugosum** (Rex) T. Macbr., N. Amer. Slime-Moulds: 105 (1899)

Figs. 13–16

Specimens studied: Locality 7, leg. ML, MR, SC & AS, 30.VIII.2007, on *Quercus* sp. wood, *CESUES 7704* in *AH 31960*.

Observations: The characteristic features of this species are the sporocarps 1–1.2 mm tall, stalked; sporotheca 0.3–0.5 mm diam., subglobose, comprised of broad polyhedral plates, whitish; stalk blackish, columella conspicuous, light yellow to whitish cream; capillitium delicate, with tubules cylindrical, *ca.* 1 μm diam., violaceous to colourless toward the ends, anastomosed and attached to the columella, the base of the sporotheca and to the peridium by their tips. Spores (8–)9–10 μm diam., verrucose; baculate by SEM, bacula thick, dispersed and regularly distributed, with small warts fused and forming small crestae between the bacula. It has been recorded for Quintana Roo, Veracruz, and Yucatan.

Didymium clavus (Alb. & Schwein.) Rabenh., Deutschl. Krypt.-Fl. 1: 280 (1844)

Specimens studied: Locality 5, leg. ML, MR, SC & AS, 29.VIII.2007, on decayed *Quercus* sp. wood, *CESUES 7699*.

Observations: This species has been recorded for Baja California, Chiapas, Chihuahua, Sonora, Veracruz, and Yucatan.

***Didymium nigripes** (Link) Fr., Syst. Mycol. 3: 119 (1829)

Specimens studied: Locality 12, leg. ML, ME, SC, RV & JC, 14.IX.2006, on decayed wood, *CESUES 7622*.

Observations: *Didymium nigripes* has been recorded previously for Baja California, Baja California Sur, Chiapas, Chihuahua, Quintana Roo, Veracruz, and Yucatan.

Didymium squamulosum (Alb. & Schwein.) Fr., Symb. Gasteromyc.: 19 (1818)

Specimens studied: Locality 3, leg. ML, MR, SC & AS, 28.VIII.2007, on *Quercus* sp. leaves, *CESUES 7681*. Locality 5, leg. ML & AB, 27.VIII.2005, *CESUES 7582*. Locality 8, Ibidem, growing on herb stems, *CESUES 7583*; Ibidem, on *Prosopis* sp. wood, *CESUES 7696*.

Observations: This species has been cited for localities throughout Mexico.

Fuligo megaspora Sturgis, Colorado Coll. Stud. Sci. Ser. 12: 443 (1913)

Specimens studied: Locality 1, leg. ML, MR, SC & AS, 27.VIII.2007, on *Quercus* sp. leaves, *CESUES 7662*. Locality 2, Ibidem, on *Quercus* sp. wood, *CESUES 7707*, *CESUES 7708*.

Observations: This species is characterized by its distinctive spores, which are unique in the genus *Fuligo* Haller (Keller & Schoknecht 1989, Lizárraga et al. 2008). *Fuligo megaspora* has been reported previously for Colima, Jalisco, Nuevo Leon, Quintana Roo, Sonora, Tlaxcala, and Yucatan.

Fuligo septica (L.) F.H. Wigg., Prim. Fl. Holsat.: 112 (1780)

Specimens studied: Locality 1, leg. ML, MR, SC & AS, 27.VIII.2007, on *Quercus* sp. leaves, *CESUES 7663*. Locality 6, Ibidem, 30.VIII.2007, *CESUES 7705*. Locality 14, leg. ML, ME, SC, RV & JC, 15.IX.2006, on decayed wood, *CESUES 7639*. Locality 16, Ibidem, *CESUES 7640*, *CESUES 7641*.

Observations: This species has been reported for numerous localities throughout Mexico.

Hemitrichia calyculata (Speg.) M.L. Farr, Mycologia 66(5): 887 (1974)

Specimens studied: Locality 18, leg. ML, ME, SC, RV & JC, 13.IX.2006, on decayed leaves, *CESUES 7605*.

Observations: This species has been commonly cited for localities throughout Mexico.

Hemitrichia foliicola (Estrada, Ram.-Ort. & Lado) Lizárraga, G. Moreno & Illana, Micol. Veget. Medit. 19(1): 38 (2004)

≡ *Calonema foliicola* Estrada, Ram.-Ort. & Lado, Mycologia 95(2): 354 (2003)

Specimens studied: Locality 4, leg. ML, MR, SC & AS, 28.VIII.2007, on dried *Quercus* sp. leaves, *CESUES 7682*.

Observations: *Hemitrichia foliicola* is characterized by having scattered sporocarps, these stalked, with orange to reddish brown hues; stalk cylindrical, filled with globose to subglobose cysts 12–16 µm diam.; spores 9–10 µm diam., warted, sometimes fused and forming small crestae more or less elongated; capillitium pale yellow and decorated with conspicuous bands or sinuous crestae and with faint, irregular veins in a reticulate pattern. This species was described as new for the science from Mexico by Estrada-Torres et al. (2003). Based on more detailed examination of additional collections, it was later transferred to *Hemitrichia* by Lizárraga et al. (2004b). The authors published a colour photomicrograph of sporocarps collected from Chihuahua, Mexico. In Mexico, this species is known only from Chihuahua and Tlaxcala.

Hemitrichia parviverrucospora (Lizárraga, G. Moreno & Illana) G. Moreno & Illana, in Pérez-Silva et al., Mycotaxon 77: 187 (2001)

≡ *H. serpula* var. *parviverrucospora* Lizárraga, G. Moreno & Illana, Ann. Bot. Fennici 36: 189 (1999)

Specimens studied: Locality 8, leg. ML, MR, ME, MC, SC & AS, 27.VIII.2007, on decayed wood, *CESUES 7664, CESUES 7665*. Locality 12, leg. ML, ME, SC, RV & JC, 14.IX.2006, on decayed wood, *CESUES 7623, CESUES 7624, CESUES 7625*. Locality 13, Ibidem, *CESUES 7626*.

Observations: The differences between *Hemitrichia parviverrucospora* and *H. serpula* (Scop.) Rostaf. ex Lister have been outlined by Lizarraga et al. (1999) and Pérez-Silva et al. (2001). The former has been recorded for Baja California Sur, Guerrero, Sinaloa and Sonora.

***Leocarpus fragilis** (Dicks.) Rostaf., Sluzowce Monogr.: 132 (1874)

Specimens studied: Locality 3, leg. ML, MR, SC & AS, 27.VIII.2007, on decayed wood, *CESUES 7666*. Ibidem, growing on *Quercus* sp. leaves and bryophytas (bryophylous), *CESUES 7667, CESUES 7668*.

Observations: This species has been recorded for Chihuahua, Estado de Mexico, Hidalgo, Jalisco, Nuevo Leon, Queretaro, Tlaxcala and Veracruz.

****Licea testudinacea** Nann.-Bremek., Acta Bot. Neerl. 14: 141 (1965)

Specimens studied: Locality 6, leg. ML, AB, MR, SG & AS, 25.VIII.2005, on *Quercus* sp. leaves, *CESUES 7579* in *AH 31980*.

Observations: Sporocarps pulvinate, solitary to gregarious, 0.05-0.2 mm, comprised of polygonal platelets. Inner surface of the peridium granular, with a single row of conspicuous tubercles hyaline regularly placed on the edge as observed by TL. Spores 12–13 µm diam., greyish to pale yellow by TL, episporium thick, with a large conspicuous pale thin zone, with verrucae sparsely distributed by phase contrast microscopy. *Licea testudinacea, L. pygmaea* (Meyl.) Ing and *L. minima* Fr. have spores ornamented with a thin zone (Lado & Pando 1997). *Licea testudinacea* was included in the dichotomous key to the genus published by Keller & Brooks (1977).

Lycogala epidendrum (L.) Fr., Syst. Mycol. 3: 80 (1829)

Specimens studied: Locality 10, leg. ML, ME, SC, RV & JC, 12.IX.2006, on decayed wood, *CESUES 7595*. Locality 16, Ibidem, 15.IX.2006, *CESUES 7642*.

Observations: This species has been amply reported for Mexico.

Lycogala flavofuscum (Ehrenb.) Rostaf., in Fuckel, Jahrb. Nassauischen Vereins Naturk. 27–28: 68 (1873)

Specimens studied: Locality 13, leg. ML, AS, MR, SG & EPS, 22.XI.2005, on decayed wood, *CESUES 7587*.

Observations: This species has been cited for Baja California, Chiapas, Distrito Federal, Guanajuato, Jalisco, Michoacan, Sonora, Tamaulipas and Tlaxcala. Lizárraga et al. (2007b) carried out a study of the pseudocapillitium and spore ornamentation under SEM.

Macbrideola lamprodermoides G. Moreno, Lizárraga & Illana, Bol. Soc. Micol. Madrid 30: 256 (2006)

Specimens studied: Locality 3, leg. ML, MR, SC & AS, 28.VIII.2007, on dried *Quercus* sp. leaves, *AH 31961*, two slides in *CESUES 7683*.

Observations: This foliicolous species was described on leaf litter of *Quercus crassifolia* Humb. & Bonpl. and *Acer grandidentatum* by Moreno et al. (2006b) from the Mexican state of Chihuahua. The description was based on 20 different collections of abundant sporocarps collected over a period of five years. A permanent slide of the holotype and most of paratypes are conserved in herbarium AH. The new Sonoran collection was observed growing on a *Quercus* sp. leaf. Sporocarps showed the typical characteristics of species, with a sporotheca that is reminiscent of *Lamproderma*, peridium iridescent and remaining in mature; stalk base hollow, orange; capillitium well-developed and dark, free ends bifurcated; spores 8–10 μm diam., spinulose by LT and SEM. In Mexico, this species was previously known only from Chihuahua.

Metatrichia horrida Ing, Trans. Brit. Mycol. Soc. 47(1): 51 (1964)

Specimens studied: Locality 1, leg. ML & AB, on decayed *Quercus* sp. wood, 27.VIII.2007, *CESUES 7669*, *CESUES 7670*, *CESUES 7671*. Locality 2, Ibidem, *CESUES 7672*. Locality 4, Ibidem, 28.VIII.2007, *CESUES 7684*. Locality 7, Ibidem, 30.VIII.2007, *CESUES 7706*. Locality 14, leg. ML, ME, SC, RV & JC, 14.IX.2006, *CESUES 7627*. Locality 15, Ibidem, *CESUES 7628*, *CESUES 7629*. Locality 16, Ibidem, 15.IX.2006, *CESUES 7643*. Locality 17, Ibidem, *CESUES 7644*. Locality 18, 13.IX.2006, on decayed wood, *CESUES 7606*.

Observations: The differences between *Metatrichia horrida* and *M. vesparium* (Batsch) Nann.-Bremek. ex G.W.Martin & Alexop., were described by Moreno et al. (1997). The authors recorded this species for the first time on the American continent. It is cited for Baja Califonia Sur, Guerrero, Sinaloa, Sonora, Quintana Roo, Veracruz, and Yucatan.

Perichaena chrysosperma (Curr.) Lister, Monogr. Mycetozoa: 196 (1894)

Specimens studied Locality 1, leg. ML, MR, SC & AS, 27.VIII.2007, growing on *Acer grandidentatum* wood, *CESUES 7673*. Locality 18, leg. ML, ME, SC, RV & JC, 13.IX.2006, on cow dung, *CESUES 7607*, *CESUES 7608*.

Observations: A study of the characteristic spinulose and pitted capillitium of this species was carried out by Lizárraga et al. (1999). This species has been cited for Baja California, Baja California Sur, Chiapas, Chihuahua, Guerrero, Jalisco, Puebla, Quintana Roo, Sinaloa, Sonora, Veracruz, and Yucatan.

Perichaena depressa Lib., Pl. Crypt. Arduenna: 378 (1837)

Specimens studied: Locality 5, leg. ML, MR, SC & AS, 29.VIII.2007, on cow dung, *CESUES 7700*. Locality 6, Ibidem, 30.VIII.2007, *CESUES 7701*, *CESUES 7702*. Locality 16, leg. ML, ME, SC, RV & JC, 15.IX.2006, on decayed wood, *CESUES 7645*.

Observations: This species usually occurs on decayed wood of gymnosperms and angiosperms, but it has been rarely observed growing on dung (Eliasson & Keller 1999). *Perichaena depressa* is cited for Baja California, Baja California Sur, Chihuahua, Morelos, Puebla, Quintana Roo, Sinaloa, Sonora, Tlaxcala, Veracruz and Yucatan.

Physarella oblonga (Berk. & M.A. Curtis) Morgan,
J. Cincinnati Soc. Nat. Hist. 19: 7 (1896)

Specimens studied: Locality 16, leg. ML, ME, SC, RV, MC & JC, 15.IX.2006, on decayed wood, *CESUES 7646*.

Observations: *Physarella oblonga* has been recorded for Chiapas, Quintana Roo, Sinaloa, Sonora, Veracruz, and Yucatan.

Physarum album (Bull.) Chevall., Fl. Gén. Env. Paris 1: 336 (1826)
= *Physarum nutans* Pers., Ann. Bot. (Usteri) 15: 6 (1795)

Specimens studied: Locality 6, leg. ML, MR, SC & AS, 28.VIII.2007, growing on *Quercus* sp. wood and leaves, *CESUES 7685*. Locality 16, leg. ML, ME, MC, SC, RV & JC, 15.IX.2006, on decayed wood, *CESUES 7647*.

Observations: This species has been reported for Baja California, Chiapas, Chihuahua, Estado de Mexico, Jalisco, Quintana Roo, Sonora, Tlaxcala, Veracruz, and Yucatan.

Physarum bivalve Pers., Ann. Bot. (Usteri) 15: 5 (1795)

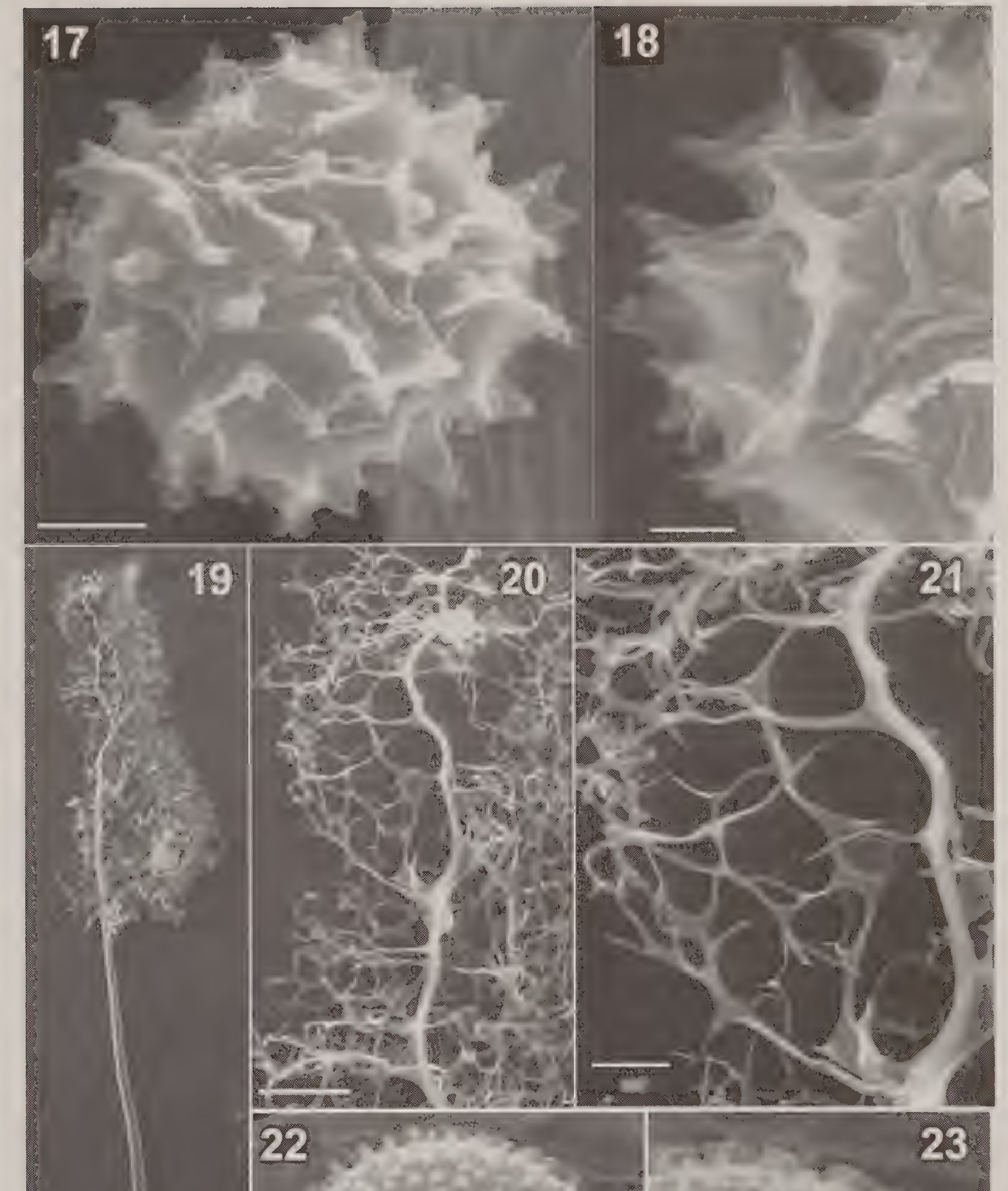
Specimens studied: Locality 1, leg. ML, AB, MR, SG & AS, 24.VIII.2005, on decayed wood, *CESUES 7567*.

Observations: This species has been cited only for Veracruz and Sonora.

Physarum bogoriense Racib., Hedwigia 37: 52 (1898)

Specimens studied: Locality 7, leg. ML, AS & MR, 30.VIII,2007, on *Quercus* sp. leaves, *CESUES 7558* in *AH 31981*. Locality 16, leg. ML, ME, MC, SC. RV & JC, 15.IX.2006, *CESUES 7648*.

Observations: This species is characterized by its abundant sporocarps, that form more or less sinuous plasmodiocarps, with white lines of dehiscence that define more or less polygonal plates; peridium double, the outer layer thick



Figs. 17–23 *Physarum echinosporum AH* 31966: 17. Spore. 18. Detail of spore ornamentation *Stemonaria irregularis AH* 31962: 19. Sporotheca. 20. Detail of sporocarp apex. 21. Detail of capillitium. 22. Spore. 23. Detail of spore ornamentation.

Scale bars. 17 and 22 = 2 µm. 18 and 23 = 1 µm. 19 = 200 µm. 20 = 50 µm. 21 = 20 µm.

with brown to yellowish brown hues and the inner layer hyaline; capillitium physaroid with abundant whitish nodules, more or less rounded, occasionally elongated; spores 8–9 µm diam. The Mexican collections agree with descriptions of the lectotype of *P. bogoriense* published by Whitney & Keller (1982). This species has been recorded previously for Guerrero, Nuevo Leon, Quintana Roo, Sonora, Tlaxcala, and Veracruz.

*****Physarum echinosporum*** Lister, J. Bot. 37: 147 (1899) Figs. 22–23

Specimens studied: Locality 13, leg. ML, MR & SG, 22.XI.2005, *CESUES 7586*. Locality 16, leg. ML, ME, SC, RV & JC, 15.IX.2006, on *Quercus* sp. leaves, *CESUES 7649* in *AH 31966*.

Observations: This species is often misidentified as *Physarum bivalve* in the field, because the plasmodiocaps are strongly laterally compressed, but the spinuose, 10–12 µm diam. spores lead to an easy determination of *P. echinosporum*. Spore ornamentation is comprised by broad crests which are thicker towards the base. According to the available literature, this is the first record for the Mexican myxobiota.

Physarum flavicomum Berk., London J. Bot. 4: 66 (1845)

Specimens studied: Locality 17, leg. ML, ME, SC, RV & JC, 13.IX.2006, on *Quercus* sp. wood, *CESUES 7609* in *AH 31968*.

Observations: This species has been recorded for the Mexican states of Puebla, Quintana Roo, Sonora, and Yucatan.

Physarum globuliferum (Bull.) Pers., Syn. Meth. Fung.: 175 (1801)

Specimens studied: Locality 11, leg. ML, ME, SC, RV & JC, 12.IX.2006, on decayed wood, *CESUES 7596*, *CESUES 7597*. Ibidem, 13.IX.2006, *CESUES 7610*. Locality 14, Ibidem, *CESUES 7611*, *CESUES 7612*. Locality 15, Ibidem, 14.IX.2006, *CESUES 7630*. Locality 16, Ibidem, 15.IX.2006, *CESUES 7650*, *CESUES 7651*, *CESUES 7652*, *CESUES 7653*. Locality 17, Ibidem, 13.IX.2006, *CESUES 7613*.

Observations: This species is recorded for the Mexican states of Chiapas, Sonora, Quintana Roo, Veracruz, and Yucatan.

Physarum leucophaeum Fr., Symb. Gasteromyc.: 24 (1818)

Specimens studied Locality 3, leg. ML, MR, SC & AS, 28.VIII.2007, on dried *Quercus* sp. leaves, *CESUES 7686*. Locality 9, leg. ML & AB, 27.VIII.2005, growing on cow dung, *CESUES 7584* in *AH 31982*.

Observations: Eliasson & Keller (1999) included a questionable report of *P. leucophaeum* by Gøtzsche (1999) in their treatment of coprophilous myxomycetes. The Mexican coprophilous collection is characterized by its stalked sporocarps, sporotheca globose to rarely lenticular, whitish, outer surface granulose by visible nodules of capillitium; stalk blackish brown to deep reddish; capillitium physaroid with elongated nodules, whitish; spores globose, 9–10 µm, pale violet, minutely roughened by TL, verrucae more notable and forming groups by SEM. It has been recorded previously for Baja California, Chiapas, Chihuahua, Nuevo Leon, Oaxaca, Sinaloa, and Sonora.

Physarum viride (Bull.) Pers., Ann. Bot. (Usteri) 15: 6 (1795)

Specimens studied: Locality 16, leg. ML, ME, SC, RV & JC, 15.IX.2006, on decayed wood, *CESUES 7654*.

Observations: This species has been cited previously for Chihuahua, Estado de Mexico, Guerrero, Nuevo Leon, Quintana Roo, Sonora, Tlaxcala, Veracruz, and Yucatan.

****_Stemonaria irregularis_** (Rex) Nann.-Bremek., R. Sharma & Y. Yamam., in Nannenga-Bremekamp et al., Proc. Kon. Ned. Akad. Wetensch., C 87(4): 456 (1984) **Figs. 17–21**

≡ *Comatricha irregularis* Rex, Proc. Acad. Nat. Sci. Philadelphia 43: 393 (1891)

Specimens studied: Locality 1, leg. ML, ME, MC & AS, 24.VIII.2005, on *Quercus* sp. wood, *CESUES 7568*; *CESUES 7569*; *CESUES 7570* in *AH 31962*.

Sporocarps stalked, blackish violet, occurring in crowded groups, 1.8–3 mm total height. Sporotheca pyriform to cylindrical, widened towards the base, 1.3–1.8 mm long and 0.3–0.6 mm diam. Peridium evanescent. Columella reaching to the sporotheca apex where it is attenuated and flexuous. Stalk deep violet, 0.7–1.7 mm height, with a base wider and fibrous. Hypothallus well developed. Capillitium forming a large-meshed violet-brown net, with numerous whitish free ends, appearing hoary by loupe, 1–3 µm diam. Spores globose to subglobose, 7–9 µm diam., verrucose. Spore ornamentation is formed by thick, sparsely distributed baculae by SEM.
Observations: This is the first record for the Mexican myxobiota.

***_Stemonitis axifera_** (Bull.) T. Macbr., N. Amer. Slime-Moulds: 120 (1899)
= *S. smithii* T. Macbr., Bull. Iowa Univ. Lab. Nat. Hist. 2: 381 (1893)
= *S. axifera* var. *smithii* (T. Macbr.) Hagelst., Mycetozoa N. Amer. 154 (1944)

Specimens studied: Locality 3, leg. ML, AB, MR, SG & AS, 23.VIII.2005, on *Pinus* sp. wood, *CESUES 7560*, *CESUES 7561*, *CESUES 7562*. Locality 10, leg. ML, ME, SC, MC, RV & JC, 12.IX.2006, on decayed wood, *CESUES 7598*.

Observations: For this cosmopolitan species, we follow the taxonomic treatment proposed by Moreno et al. (2004) whereby these authors combine *Stemonitis smithii* with *S. axifera*. The latter species has been cited for Baja California, Chiapas, Estado de Mexico, Jalisco, Morelos, Puebla, Quintana Roo, Tabasco, Tlaxcala, Veracruz, and Yucatan.

Stemonitis fusca Roth, Bot. Mag. (Römer & Usteri) 1(2): 26 (1787)
= *S. nigrescens* Rex, Proc. Acad. Nat. Sci. Philadelphia 43: 392 (1891)

Specimens studied: Locality 1, leg. ML & AB, 24.VIII.2005, on *Quercus* sp. and *Acer grandidentatum* leaves, *CESUES 7571*. Locality 18, leg. ML, ME, SC, MC, RV & JC, 14.IX.2006, on decayed wood and leaves, *CESUES 7631*. Locality 4, leg. ML, SC, MR & AS, 28.VIII.2007, on *Quercus* sp. wood, *CESUES 7687*.

Observations: For determination of species, we follow the taxonomic concepts proposed by Castillo et al. (1997). These authors combine *Stemonitis nigrescens* with *S. fusca*. The latter species has been cited for Baja California, Baja California Sur, Chiapas, Chihuahua, Jalisco, Nuevo Leon, Puebla, Quintana Roo, Sonora, Tamaulipas, Tabasco, Tlaxcala, Veracruz, and Yucatan.

Stemonitis splendens Rostaf., Sluzowce Monogr.: 195 (1874)
= *S. lignicola* Nann.-Bremek., Proc. Kon. Ned. Akad. Wetensch., C 76(5): 478 (1973)

Specimens studied: Locality 1, leg. ML, AB, MR, SG & AS, 23.VIII.2005, on *Acer grandidentatum* wood, *CESUES 7563*. Locality 8, Ibidem, 27.V.2005, on the decayed wood of *Ipomoea arborescens*, *CESUES 7559*. Locality 16, leg. ML, ME, SC. RV & JC, 15.IX.2006, on *Quercus* sp. leaves, *CESUES 7655*.

Observations: This species was identified following the taxonomic treatment proposed by Moreno et al. (2004). These authors combine *Stemonitis lignicola* with *S. splendens*. The latter species is cited for Baja California, Baja California Sur, Chiapas, Chihuahua, Distrito Federal, Morelos, Puebla, Quintana Roo, Sinaloa, Sonora, Tabasco, Tlaxcala, Veracruz, and Yucatan.

Stemonitopsis typhina (F.H. Wigg.) Nann.-Bremek., Nederlandse Myxomyceten (Zutphen): 209 (1975)

Specimens studied: Locality 2, leg. ML, MR, SC & AS, 28.VIII.2007, on Acer grandidentatum wood, CESUES 7688, CESUES 7689. Locality 4, Ibidem, CESUES 7690. Locality 11, leg. ML, ME, SC, RV & JC, 12.IX.2006, on horse dung, CESUES 7599. Locality 14, Ibidem, 15.IX.2006, CESUES 7656, CESUES 7657, CESUES 7658, CESUES 7659. Locality 18, Ibidem, 13.IX.2006, on decayed wood, CESUES 7614, CESUES 7615.

Observations: An SEM study of the spore ornamentation was carried out by Moreno et al. (2004). Eliasson & Keller (1999) did not report this species as growing on dung. It has been reported previously for Chiapas, Chihuahua, Jalisco, Nuevo Leon, Puebla, Quintana Roo, Sinaloa, Veracruz, and Yucatan.

Trichia affinis de Bary, in Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 336 (1870)

Specimens studied: Locality 1, leg. ML, AB, MR, SG & AS, 24.VIII.2005, on *Quercus* sp. wood, *CESUES 7572*. Ibidem, leg. ML, MR, SC & AS, 27.VIII.2007, on decayed wood, *CESUES 7674*, *CESUES 7675*.

Observations: The taxonomic concepts of Lado & Pando (1997) was followed for determination of species. It is cited for the Mexican states of Quintana Roo, Sonora, and Yucatan.

Trichia agaves (G. Moreno, Lizárraga & Illana) Mosquera, Lado, Estrada & Beltrán-Tej., in Lado, Cuad. Trab. Fl. Micol. Iber. 16: 82 (2001)

≡ *Hemitrichia agaves* G. Moreno, Lizárraga & Illana, in Moreno et al., Rivista Micol. 43(1): 6 (2000)

Specimens studied: Locality 1, leg. ML & AB, 24.VIII.2005, on *Agave* sp. debris, *CESUES 7573*. Locality 3, leg. ML, MR, SC & AS, 28.VIII.2007, *CESUES 7691*.

Observations: This species, which is associated with succulent habitats, was described as new for science by Moreno et al. (2000), based on collections from Mexico and Spain The known distribution of this species in Mexico is from the states of Baja California, Chihuahua, Hidalgo, Oaxaca, Puebla, Sonora, Tlaxcala, and Veracruz.

***Trichia lutescens** (Lister) Lister, J. Bot. 35: 216 (1897)

Specimens studied: Locality 1, leg, ML & AB, 24.VIII.2005, on *Quercus* sp. leaves, *CESUES 7574*. Locality 6, leg. ML, AB, MR, SG & AS, 25.VIII.2005, on *Quercus* sp. wood, *CESUES 7580* in *AH 31983*.

Observations: Although only three sporocarps were collected, they showed the characteristics of the species such as small size of the sporocarps, 0.3–0.6 mm diam., bright yellow peridium, elaters 3–5 µm diam. and spores 9–11 µm diam. It has been recorded only for Jalisco.

***Trichia varia** (Pers. ex J.F. Gmel.) Pers., Neues Mag. Bot. 1: 90 (1794)

Specimens studied: Locality 2, leg. ML, MR, SC & AS, 28.VIII.2007, on decayed *Acer grandidentatum* wood, *CESUES 7692, CESUES 7693, CESUES 7694, CESUES 7695.*

Observations: This cosmopolitan species was recorded previously for Baja California, Chihuahua, Jalisco, and Veracruz.

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Literature Cited

Castillo A, Moreno G, Illana C. 1993. A new species of *Comatricha* with incompletely reticulated spores from Spain. Mycotaxon 46: 315–319.

Castillo A, Moreno G, Illana C, Lago J. 1997. A critical study of some *Stemonitales*. Mycological Research 101: 1329–1340.

Castillo A, Moreno G, Illana C, Singer H. 2002. Notes on two violet species belonging to *Physarales* (*Myxomycetes*). Mycotaxon 82: 347–356.

Castillo A, Moreno G, Illana C, Sánchez A. 2005. Two rare species recently described in the genus *Comatricha*. Revista Catalana de Micología 27: 153–158.

CONANP. 2003. Estudio previo justificativo "Área de Protección de Flora y Fauna Mavavi. SEMARNAT, México.

Eliasson UH, Keller HW. 1999. Coprophilous *Myxomycetes*: updated summary, key to species, and taxonomic observations on *Trichia brunnea*, *Arcyria elaterensis*, and *Arcyria stipata*. Karstenia 39: 1–10.

Estrada-Torres A, Lado C, Rodríguez-Palma M. 2001. Two new species of *Myxomycetes* from a tropical deciduous forest of Mexico. Mycologia 93: 744–750.

Estrada-Torres A, Ramírez-Ortega JM, Lado C. 2003. *Calonema foliicola* a new myxomycete from Mexico. Mycologia 95: 354–359.

Gøtzsche HF. 1999. Myxomycetes from Greenland. Opera Botanica 100: 93–103.

Guerra JM. 1998. Ajos-Bavispe reserva forestal nacional y refugio de fauna silvestre. In: http://www.imades.org/entorno/entorno02/ajos.htm

Keller HW, Brooks TE. 1977. Corticolous *Myxomycetes* VII: Contribution toward a monograph of *Licea*, five new species. Mycologia 69: 667–684.

Keller HW, Schoknecht JD. 1989. *Fuligo megaspora*, a myxomycete with unique spore ornamentation. Mycologia 81: 454–458.

Lado C, Pando F. 1997. Flora Mycologica Iberica Vol. 2. *Myxomycetes*, I. *Ceratiomyxales*, *Echinosteliales*, *Liceales*, *Trichiales*. Real Jardín Botánico Madrid, J. Cramer.

Lizárraga M, Moreno G, Illana C. 1997. The Myxomycetes from Baja California (Mexico). I. Mycotaxon 63: 287–300.

Lizárraga M, Illana C, Moreno G. 1999. SEM studies of the myxomycetes from the Peninsula of Baja California (Mexico), II. *Hemitrichia* to *Trichia*. Annales Botanici Fennici 36: 187–210.

Lizárraga M, Moreno G, Illana C. 2004a. Contribución al estudio de los Myxomycetes de la Península de Baja California, México. Boletín de la Sociedad Micológica de Madrid 22: 43–54.

Lizárraga M, Moreno G., Illana C, Singer H. 2004b. *Calonema foliicola*, a myxomycete with a difficult taxonomic position. Micologia e Vegetazione Mediterranea 19: 38–42.

Lizárraga M, Moreno G, Illana C. 2005a. Myxomycetes from Chihuahua, Mexico. 2. Österreische Zeitschrift Pilzkunde 14: 105–121.

Lizárraga M, Moreno G, Illana C, Singer H. 2005b. Myxomycetes from Chihuahua, Mexico III. Mycotaxon 93: 75–88.

Lizárraga M, Moreno G, Esqueda M, Sánchez A, Coronado M. 2007. Myxomycetes from Sonora, Mexico. 3: National forest reserve and wildlife refuge, Ajos-Bavispe. Mycotaxon 99: 291–301.

Lizárraga M, Moreno G, Esqueda M, Coronado M. 2008. Myxomycetes of Sonora, Mexico. 4: Sierra de Alamos-Rio Cuchujaqui Biosphere Reserve. Mycotaxon 103 [in press].

Mobin M, Cavalcanti LH. 1999. Stemonitales (*Myxomycetes*) do Parque Nacional de Sete Cidades (Piauí, Brasil). Acta Botanica Brasilica 13: 139–148.

Moreno G, Lizárraga M, Illana C. 1997. *Metatrichia horrida* (*Myxomycetes*), an African species in the Baja California Peninsula (Mexico). Mycotaxon 64: 385–392.

Moreno G, Lizárraga M, Illana C, Castillo A, Oltra M. 2000. *Hemitrichia agaves* sp. nov., un nuovo *Myxomycetes* delle piante grasse dal Messico e dalla Spagna. Rivista di Micologia 1: 5–16.

Moreno G, Singer H, Sánchez A, Illana C. 2004. A critical study of some *Stemonitales* of North American herbaria and comparison with European nivicolous collections. Boletín de la Sociedad Micológica de Madrid 28: 21–44.

Moreno G, Lizárraga M, Esqueda M, Pérez-Silva E, Herrera T. 2006a. Myxomycetes de Sonora, México. II: Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe. Revista Mexicana de Micología 22: 13–23.

Moreno G, Lizárraga M, Illana C. 2006b. *Macbrideola lamprodermoides* sp. nov., a new myxomycete from Mexico. Boletín de la Sociedad Micológica de Madrid 30: 255–263.

Moreno G, Lizárraga M, Illana C. 2007. Catálogo de los Myxomycetes de México. Boletín de la Sociedad Micológica de Madrid 31: 187–229.

Pérez-Silva E, Herrera T, Esqueda M, Illana C, Moreno G. 2001. Myxomycetes de Sonora. I. Mycotaxon 77: 181–192.

Rammeloo J. 1975a. Structure of the epispore in the *Stemonitales* (*Myxomycetes*) as seen with the scanning electron microscope. Bulletin de la Société Royale de Botanique de Belgique 45: 301–306.

Rammeloo J. 1975b. Structure of the epispore in the *Trichiaceae* (*Myxomycetes*) as seen with the scanning electron microscope. Bulletin de la Société Royale de Botanique de Belgique 107: 353–359.

Whitney KD, Keller HW. 1982. A new species of *Badhamia*, with notes on *Physarum bogoriense*. Mycologia 74: 619–624.

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Aphyllophoraceous wood-inhabiting fungi on *Quercus* spp. in Italy

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Abstract — 240 species representing 100 genera of aphyllophoraceous fungi growing on *Quercus* spp. in Italy are listed. Some species are considered rare or infrequent in Italy, e.g. *Bulbillomyces farinosus, Dendrothele dryina, Fomitopsis iberica, F. spraguei, Hyphoderma incrustatum, Inonotus andersonii, Lindtneria hydnoidea.* Complete checklist of fungi is available on http://www.mycotaxon.com/resources/weblist.html.

Key words — lignicolous fungi, diversity, oak woods

Introduction

In line with previous reports on Italian lignicolous fungi (Bernicchia 2000, Mayrhofer et al. 2001, Pérez Gorjón et al. 2006, Bernicchia et al. 2007a, b, c), a list of aphyllophoraceous fungi growing on *Quercus* spp. is announced. Oak forests are widely distributed in Europe, and 20 taxa of the genus *Quercus* L. occur in the European sector of Mediterranean region (Webb 1993). In Italy, the following species are widely distributed: *Q. cerris* L., *Q. ilex* L., *Q. pubescens* Willd., *Q. petraea* (Matt.) Liebl., *Q. robur* L. subsp. *robur* and *Q. suber* L.; these were the most common substrates from which aphyllophoraceous fungi have been collected.

In Italy, oaks are distributed from sea level to 1800 m and form parts of several vegetation types such as maquis, arid woods, evergreen woods on siliceous rocks, woods on acid and sub acid soils, arid shrubby woodlands on limestone, heaths and olive tree farms.

Materials and methods

During the last 25 years, fungi have been collected in the most representative oak forests of Italy. Samples were taken to the laboratory for microscopical examination and identification following Eriksson & Ryvarden (1973, 1975, 1976), Eriksson et al. (1978, 1981, 1984), Burdsall (1985), Hjortstam et al. (1988), Ryvarden & Gilbertson (1993, 1994), Kõljalg (1995), Núñez & Ryvarden (1997) and Bernicchia (2005). All the specimens are kept in Herbarium HUBO, except the specimens PAL/Mic, deposited in the Herbarium Mediterraneum (PAL) (these last collections have provisional numbers), and a few specimens belonging to L. Ryvarden and L. Arras. The list also cites information provided by Bernicchia (1995, 2001), Larsen & Bernicchia (1990), and Onofri (2005); nomenclature follows mainly Kirk et al. (2001) and CBS (2008) with some minor exceptions in which Donk (1984), Hjortstam (1998), Hjortstam & Ryvarden (1990), Parmasto et al. (2004), Ryvarden (1991) and Ryvarden & Gilbertson (1994) are considered. A list and map of the collection localities are available on the annotated species weblist.

Results

In this survey 965 specimens belonging to 240 species of aphyllophoraceous wood-inhabiting fungi collected on different species of *Quercus* have been identified. The annotated species list posted on the internet provides additional comments on distribution or frequency for most of the species.

Rare or infrequent species include *Bulbillomyces farinosus* (Bres.) Jülich, *Dendrothele dryina* (Pers.) P.A. Lemke, *Fomitopsis iberica* Melo & Ryvarden, *F. spraguei* (Berk. & M.A. Curtis) Gilb. & Ryvarden, *Hyphoderma incrustatum* K.H. Larss., *Inonotus andersonii* (Ellis & Everh.) Černý, *Lindtneria hydnoidea* Bernicchia & Ryvarden, *L. leucobryophila* (Henn.) Jülich, *L. panphyliensis* Bernicchia & M.J. Larsen, *L. trachyspora* (Bourdot & Galzin) Pilát, *Mycoacia nothofagi* (G. Cunn.) Ryvarden, *Oligoporus simanii* (Pilát) Bernicchia, *Peniophora pseudoversicolor* Boidin, *Phlebia georgica* Parmasto, *Punctularia strigosozonata* (Schwein.) P.H.B. Talbot, *Scytinostromella heterogenea* (Bourdot & Galzin) Parmasto, *Sistotrema subtrigonospermum* D.P. Rogers, *Trechispora clancularis* (Park.-Rhodes) K.H. Larss., *T. silvae-ryae* (J. Erikss. & Ryvarden) K.H. Larss., *Vuilleminia coryli* Boidin et al. and *V. pseudocystidiata* Boidin et al.

Some species have a primarily Mediterranean distribution, such as *Hexagonia nitida* Durieu & Mont., *Hyphoderma transiens* (Bres.) Parmasto, *Peniophora meridionalis* Boidin, *P. pseudoversicolor*, *P. versicolor* (Bres.) Sacc. & P. Syd., *Perenniporia meridionalis* Decock & Stalpers, *P. ochroleuca* (Berk.) Ryvarden, *Phanerochaete martelliana* (Bres.) J. Erikss. & Ryvarden, *Phellinus erectus*

A. David et al., *P. rosmarini* Bernicchia, *Scytinostroma aluta* Lanq., *Skeletocutis percandida* (Malençon & Bertault) Jean Keller, *Stereum reflexulum* D.A. Reid, *Trametes ljubarskii* Pilát and *Vuilleminia megalospora* Bres.

Some species more common on coniferous substrata than on hardwoods are *Antrodia serialis* (Fr.) Donk, *Hyphodontia hastata* (Litsch.) J. Erikss., *Hypochniciellum molle* (Fr.) Hjortstam, *Phlebiopsis gigantea* (Fr.) Jülich and *Tubulicrinis medius* (Bourdot & Galzin) Oberw.

Conclusions

The aphyllophoraceous wood-inhabiting macrofungi growing on *Quercus* spp. show a very high diversity in Italy compared to other investigated substrata; 203 species on *Pinus* spp. (Bernicchia et al. 2007b), 190 on *Abies alba* (Bernicchia et al. 2007a), 166 on *Fagus sylvatica* (Bernicchia et al. 2007c), 126 on *Castanea sativa* (Mayrhofer et al. 2001), 105 on *Juniperus* spp. (Bernicchia 2000) and 52 on *Arbutus unedo* (Pérez Gorjón et al. 2006). This higher diversity level may be due partly to the abundant amount of woody debris of *Quercus* fallen on the ground. Besides silvicultural management of the Italian Forestry Administration is to be considered as an important factor of appearance of wood decomposing fungi in forest ecosystems; in fact the action of cutting and the accumulation of logs and branches in the ground cover stimulate pathogens and wood-inhabiting fungi to colonize such type of substrata. Several species are widely distributed, while the presence of some rare taxa could provide very interesting data that might help delimit special conservation areas and be useful for compiling red lists of endangered species.

Acknowledgements

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Literature cited

Bernicchia A. 1995. *Aphyllophorales* della Riserva Naturale Integrale di Sasso Fratino (Forlì), Italia. Primo contributo. Gior. Bot. It. 129: 837-857.

Bernicchia A. 2000. Wood-inhabiting Aphyllophoraceous fungi on *Juniperus* spp. in Italy. Mycotaxon 75: 241-256.

Bernicchia A. 2001. A checklist of Corticioid, Polyporoid and Clavarioid fungi (*Basidiomycetes*) from the Emilia-Romagna region, Italy. Sydowia 53(1): 1-33.

Bernicchia A. 2005. *Polyporaceae* s.l. Fungi Europaei, 10. Ed. Candusso. Alassio. Italy.

Bernicchia A, Savino E, Pérez Gorjón S. 2007a. Aphyllophoraceous wood-inhabiting fungi on *Abies alba* in Italy. Mycotaxon 100: 185-188.

Bernicchia A, Savino E, Pérez Gorjón S. 2007b. Aphyllophoraceous wood-inhabiting fungi on *Pinus* spp. in Italy. Mycotaxon 101: 5-8.

Bernicchia A, Venturella G, Saitta A, Pérez Gorjón S. 2007c. Aphyllophoraceous wood-inhabiting fungi on *Fagus sylvatica* in Italy. Mycotaxon 101: 229-232.

Burdsall HH. 1985. A Contribution to the Taxonomy of the Genus *Phanerochaete* (*Corticiaceae, Aphyllophorales*). Mycol. Mem. 10, J. Cramer, Germany. 165 pp.

CBS. 2008. *Aphyllophorales* database. www.cbs.knaw.nl/databases/index.htm.

Donk MA. 1984. Check list of European polypores. North. Holland Publ. Comp. Amsterdam. The Netherlands. 469 pp.

Eriksson J, Ryvarden L. 1973-1975-1976. The *Corticiaceae* of North Europe. Vols. 2-3-4: 60-886. Fungiflora, Oslo, Norway.

Eriksson J, Hjortstam K, Ryvarden L. 1978-1981-1984. The *Corticiaceae* of North Europe. Vols. 5-6-7: 887-1449. Fungiflora, Oslo, Norway.

Hjortstam K. 1998. A checklist to genera and species of corticioid fungi (*Basidiomycotina, Aphyllophorales*). Windahlia 23: 1-54.

Hjortstam K, Larsson KH, Ryvarden L. 1988. The *Corticiaceae* of North Europe. Vol. 8: 1450-1631. Fungiflora, Oslo, Norway.

Hjortstam K, Ryvarden L. 1990. *Lopharia* and *Porostereum* (*Corticiaceae*). Synopsis Fung. 4. Fungiflora, Oslo, Norway. 68 pp.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. 9th edition. CABI Publishing, Oxon, U.K. 655 pp.

Kõljalg U. 1995. *Tomentella* (*Basidiomycota*) and related general in Temperate Eurasia. Synopsis fungorum 9. Fungiflora, Oslo, Norway. 213 pp.

Larsen M, Bernicchia A. 1990. *Lindtneria panphyliensis* sp. nov. from Po Valley, Italy. Mycotaxon 37: 349-352.

Mayrhofer S, Peintner U, Bernicchia A. 2001. Wood-inhabiting aphyllophoraceous fungi on *Castanea sativa* in Italy. Mycotaxon 80: 267-280.

Núñez M, Ryvarden L. 1997. The genus *Aleurodiscus* (*Basidiomycotina*). Synopsis Fung. 12. Fungiflora, Oslo, Norway. 164 pp.

Onofri S. (coord.). 2005. Checklist of Italian fungi. Carlo Delfino editore. 384 pp.

Parmasto E, Nilsson RH, Larsson KH. 2004. Cortbase version 2 – extensive updates of a nomenclatural database for corticioid fungi (*Hymenomycetes*). Phyloinformatics 5: 1-7.

Pérez Gorjón S, Bernicchia A, Baptista Gibertoni T. 2006. Aphyllophoraceous wood-inhabiting fungi on *Arbutus unedo* in Italy. Mycotaxon 98: 159-162.

Ryvarden L. 1991. Genera of Polypores. Nomenclature and Taxonomy. Synopsis Fung. 5. Fungiflora, Oslo, Norway. 363 pp.

Ryvarden L, Gilbertson, RL. 1993-1994. European Polypores. Synopsis Fung. 6-7. Fungiflora, Oslo, Norway. 743 pp.

Webb DA, 1993. Flora Europaea, 1 (second edition). Cambridge University Press, Cambridge.

MYCOTAXON

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Geastrum entomophilum, a new earthstar with an unusual spore dispersal strategy

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Abstract — A new species of gasteroid basidiomycete in Northeast Brazil, *Geastrum entomophilum* is described and illustrated. *Geastrum* species are known for dispersing their spores by a bellows type mechanism; however, in the fruit bodies of the new species, various beetles were found inside the gleba, which likely contribute to spore dispersal. This taxon is morphologically separated from the other known species primarily by the endoperidium ornamentation formed by fascicles of worm-shaped hyphae.

Key words — Atlantic rainforest, tropical fungi, gasteromycetes, *Geastraceae*, taxonomy.

Introduction

Six new *Geastrum* species have been discovered in the new millennium: *G. ovalisporum* Calonge & Mor.-Arr. (Calonge et al. 2000), *G. setiferum* Baseia (Baseia & Milanez 2002), *G. albonigrum* Calonge & M. Mata (Calonge & Mata 2004), *G. pleosporus* Douanla-Meli (Douanla-Meli et al. 2005), *G. heptaplex* Gardezi (Gardezi 2005), and *G. hirsutum* Baseia & Calonge (Baseia & Calonge 2006). These data, added to recent estimates (Hawksworth 2001), lead us to believe that the species diversity is unknown and widespread, mainly in tropical regions, and in need of further study.

Geastrum species are known for dispersing their spores by a bellows type mechanism that is activated by the raindrops, run-off drops from vegetation, influence of wind and to some extent the falling of solid objects and other external agents (Sunhede 1989). The effect on spore liberation and spore dispersal by invertebrates is scarce in the literature. However, certain coleoptera and ants have been observed to carry spores passively (Sunhede 1974).

The ecology of tropical fungi is also little understood, and above all the interrelations between fungi and terrestrial arthropods and the effects of this association on spore dispersal. There are a number of studies on this topic (Bultman et al. 2000, Oliveira & Morato 2000, Shaw & Roberts 2002). However, little information is available on the richness of fungal species, the arthropods involved and the degree of interdependence between these organisms. Studies that aim to elucidate these interrelations are very important for understanding the role of terrestrial arthropods in fungal diversity in these ecosystems.

Material and methods

Field expeditions were made in June 2006 in an Atlantic Forest remnant in Parque Estadual Dunas do Natal (05°46' S, 35° 12 W), state of Rio Grande do Norte. Fruit bodies were photographed and examined in the field. A taxonomic study was performed by observing macro and microscopic features according to Sunhede (1989). We also analyzed the ultrastructure under a XL20 scanning electron microscope (SEM). Colors were determined according to Kornerup & Wanscher (1978), with the key color in parentheses, and simultaneously described.

For the ecological study, observations were made to determine the presence of arthropods in the fruit bodies; when this was confirmed, the animals were collected using an entomological net and stored in plastic containers. These containers were kept in a laboratory freezer in order to kill and preserve the arthropods. Later, the intestinal contents were extracted and examined under scanning electron microscope. The exoskeleton surface was also surveyed in order to identify the presence of spores.

Results

Geastrum entomophilum Fazolino, Calonge & Baseia, **sp. nov.** Fig. 1

MycoBank MB 511312

Basidiomata juvene hypogeae, depresse globulare, 1 2 cm latum, 0.8 1.5 cm altus. Exoperidium apertum 3.5 5.5 cm latum in 5 8 radios fornicatus; subhygroscopicus, stratum myceliale albidus lutescens cum substrato adhaerens; stratum medium pallidus luteus, tenue; stratum internum aurantiacus cinereus, crassus, persistens. Endoperidium pruinatus, protuberans cum hyphis vermiformis, fuscus cinereus, sessile, globulare, 0.7 1.5 cm latum; peristomio fibrillosus vel laceratus, concolorus. Gleba cinereae; columella distinctae; sporis globosis, 2.8 3.5 µm latum, brunneis, verrucis uniformibus subtilibus brevibus ornatae; hyphis capillitii longis, 3 6µm latum, brunneis,rugatus, non ramificatum.

Holotypus: *Brasil, Rio Grande do Norte, Natal, Parque Estadual Dunas de Natal, ad foliis putrescentibus, 08-VII-2006, legit Fazolino, E.P. & Leite A.G., UFRN-fungos 504.* **Isotypus:** *MA-Fungi 70785.*

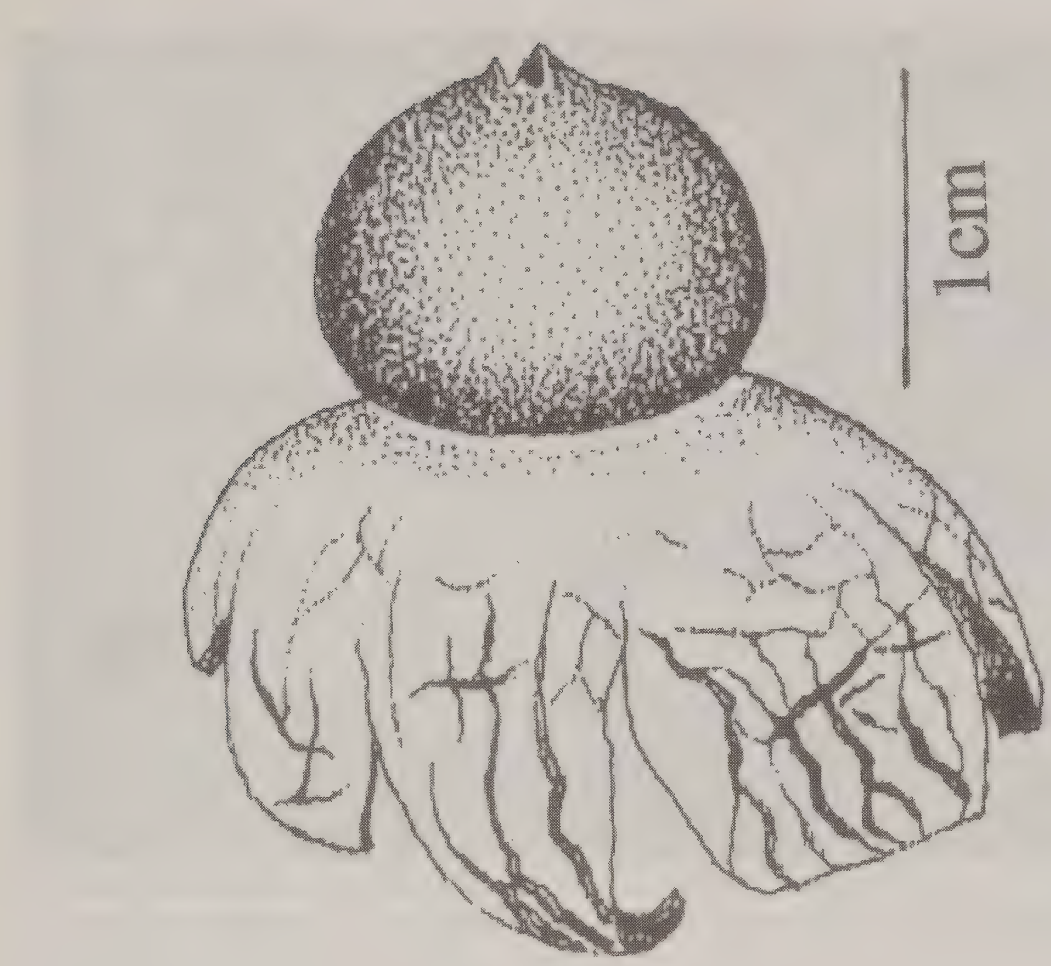


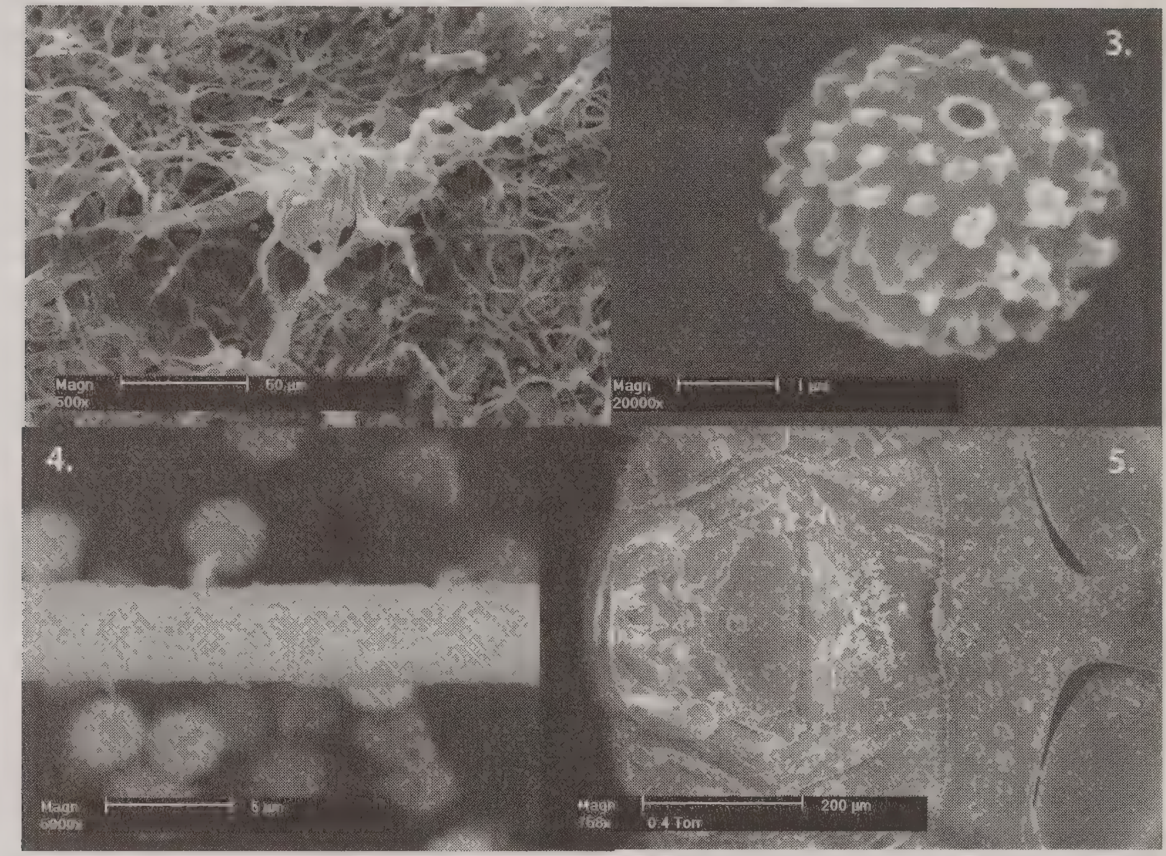
Fig. 1. *Geastrum entomophilum,* basidioma (from holotype).

Etymology: "entomophilum" refers to its association with insects.

Basidiomata hypogeous when young, depressed-globose, 1 2 cm broad, 0.8 1.5 cm high. Exoperidium when open 3.5-5.5 cm broad, subhygroscopic (Fig. 1), split into 5 8 acute, arched rays; mycelial layer with adhering substrate debris formed by 2 3 µm diam, yellowish-white (4A2) hyphae; fibrous layer thin, whitish (4A2), made of up to 8 µm diam, hyaline hyphae, with or without lumen; pseudoparenchymatous layer thick, persistent, greyish-orange (5B3), made of up to 50 µm diam, globose to irregular elements. Endoperidium 0.7 2.3 cm diam, sessile, globose, pruinose, covered by 0.3 0.5 mm high, cylindric, blackish, protuberances, which are made of worm-shaped bended hyphae without lumen, forming fascicles 40 50 x 3 4 µm, (Fig. 2), greyish-brown (6D3); peristome fibrillose to lacerate, non delimited, concolor. Gleba grey (7F1), columella distinct; basidiospores 2.8 3.5 µm broad, globose, dark brown, with irregular 0.5 0.8 µm high warts (Fig. 3). Capillitium hyphae 3-6 µm broad, rugose, not branching, brown (Fig. 4).

HABITAT: On decaying leaves of Atlantic rainforest.

KNOWN DISTRIBUTION: Brazil



Figs. 2-5. *Geastrum entomophilum* (from holotype). 2. Endoperidium ornamentation formed by a fascicle of worm-like hyphae. 3. Basidiospore. 4. Capillitium. **Fig.** 5. Basidiospores adhered to the arthropod exoskeleton.

Discussion

Geastrum entomophilum is a distinctive species, recognized by the following features: dark and sessile endoperidium with a verruculose surface, which is formed by worm-like hyphae; peristome indefinite and fibrillose.

The presence of protruding hyphae in the endoperidium of the species of *Geastrum* is a rather common feature (Sunhede 1989), but the fact of forming cylindrical warts with close intermingled worm-like elements, has been only observed in the case of *G. entomophilum*, as far as we know. Similar worm-like hyphae can be observed in *G. rufescens* Pers. and *G. welwitschii* Mont. (Sunhede 1989), but in these cases they appear isolated and never forming fascicles. The morphology of exoperidium and endoperidium and the bigger size of the spores (*G. rufescens* with 5-6 µm and *G. welwitschii* with 4.5-5 µm) point out the differences of these two species with *G. entomophilum*.

Field observations showed several minuscule arthropods (*Coleoptera*) visiting *Geastrum entomophilum* fruit bodies. These small beetles were found inside mature basidiomata, mixed with the gleba. SEM analysis showed a large number of spores in the intestinal contents, showing that they were ingested by the insect. This suggests that these animals become dispersing agents, besides transporting the spores adhered to the exoskeleton (Fig. 5), and also through their excrements. The combination of characters such as the endoperidial protruding worm-like hyphae and the typical spore dispersal, with the help of insects induced us to propose *G. entomophilum* as a new species.

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References

Baseia IG, Milanez AI. 2002. *Geastrum setiferum* (*Gasteromycetes*): a new species with a setose endoperidium. Mycotaxon 84: 135-139.

Baseia IG, Calonge FD. 2006. *Geastrum hirsutum:* a new earthstar fungus with a hairy exoperidium. Mycotaxon 95: 301-304.

Bultman TL, Welch AM, Boning RA, Bowdish TI. 2000. The cost of mutualism in a fly-fungus interaction. Occologia 124: 85-90.

Calonge FD, Moreno-Arroyo B, Gómez J. 2000. Aportación al conocimiento de los Gasteromycetes, Basidiomycotina, de Bolivia (América del Sur). *Geastrum ovalisporum* sp. nov. Boletín de la Sociedad Micológica de Madrid, 25:271-276.

Calonge FD, Mata M. 2004. A new species of *Geastrum* from Costa Rica and Mexico. Boletín de la Sociedad Micológica de Madrid 28: 331-335.

Douanla-Meli C, Langer E, Calonge FD. 2005. *Geastrum pleosporus* sp. nov., a new species of *Geastraceae* identified by morphological and molecular phylogenetic data. Mycological Progress 4(3): 239-250.

Gardezi S. 2005. Notes on *Scleroderma*, puffballs and *Geastrum* of Azad Jammu and Kashmir, Pakistan. Archives of Phytopathology and Plant Protection 38(2): 113-122.

Hawksworth DL. 2001. The magnitude of fungal diversity: the 1.5 million species estimate revised. Mycological Research 105 (12): 1422-1432.

Kornerup A, Wanscher JH. 1978. Methuen handbook of colours. Third edition. Eyre Methuen. London. 252 pp.

Oliveira ML, Morato EF. 2000. Stingless bees (*Hymenoptera, Meliponini*) feeding on stinkhorn spores (*Fungi, Phallales*): robbery or dispersal? Revista Brasileira de Zoologia 17(3): 881-884.

Shaw DE, Roberts P. 2002. Bees and phalloid exudate. Mycologist 16(3): 109.

Sunhede S. 1974. Studies in *Gasteromycetes.* I. Notes on spore liberation and spore dispersal in *Geastrum*. Svnsk Bot. Tidskr 68: 329-343.

Sunhede S. 1989. *Geastraceae* (*Basidiomycotina*). Morphology, ecology and systematics with special emphasis on the North European species. (Synopsis Fungorum 1). Fungiflora, Oslo, 535 pp.

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Microbotryum vivipari sp. nov. and *Anthracoidea mulenkoi* new to China

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Abstract — A new species, *Microbotryum vivipari* on *Polygonum viviparum*, which was collected from Gansu Province, is described. *Anthracoidea mulenkoi* on *Kobresia cuneata*, new to China, is also reported.

Key words — *Microbotryales*, smut fungi, taxonomy

A new species of *Microbotryum* on *Polygonum viviparum* was discovered in the Herbarium of the Institute of Botany, Chinese Academy of Sciences (PE) by Mr. Cao Ziyu. It was collected from Gansu Province in northwestern China in 1964. No collector was recorded for the specimen. Its sori infect all of the flowers in an inflorescence as well as parts of the leaves. We describe the new species as:

Microbotryum vivipari S.H. He & L. Guo, **sp. nov.** **Figs. 1-4**

MycoBank MB 511674.

Sori saepe in floribus omnibus eiusdem inflorescentiae evoluti, 1.5–6 mm longi, 1–2 mm lati, raro in foliis, primum membrana cooperti, deinde rupti. Massa sporarum atropurpurea, pulverulenta. Ustilosporae subglobosae ovoideae, ellipsoideae vel leniter irregulares, 11–20(–30) x 9–15(–17.5) µm, brunneopurpurea; pariete 0.5–1 µm crasso, dense verruculoso.

Sori usually in all flowers in an inflorescence, swollen, with remnants of host tissue resembling a columella, 1.5–6 mm long, 1–2 mm wide, rarely also in parts of leaves, at first covered by a pale brown membrane, which later ruptures.

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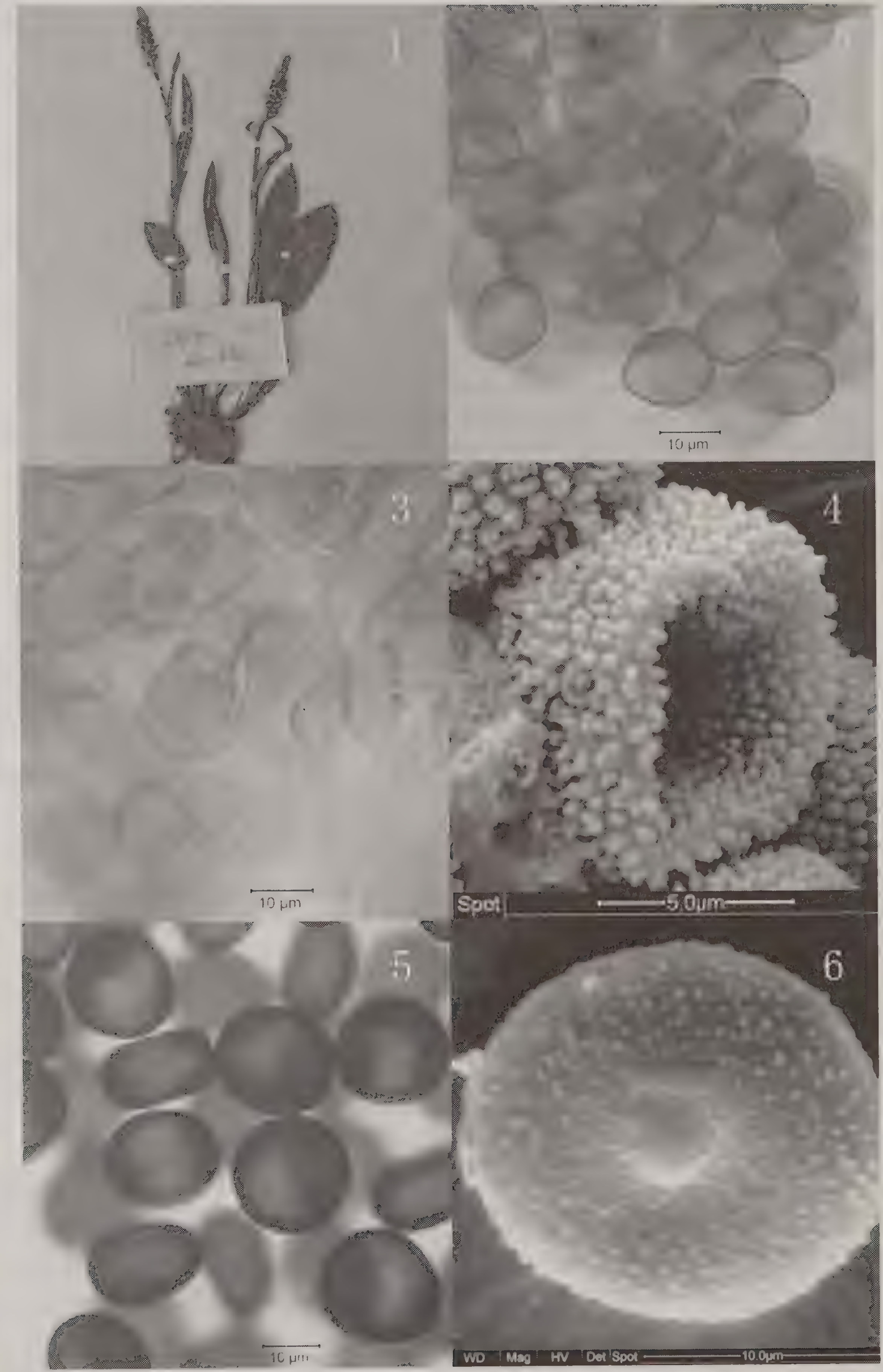
1
10 µm
3
10 µm
4
Spot
5.0µm
5
10 µm
6
WD
Mag
HV
Det
Spot
10.0µm

Spore mass blackish-violet, powdery. Ustilospores subglobose, ovoid, ellipsoidal or slightly irregular, 11–20(–30) x 9–15(–17.5) µm, brownish-violet; wall 0.5–1 µm thick, densely verruculose.

Specimens examined—On *Polygonum viviparum* L. (*Polygonaceae*), China: Gansu, Tianzhu, Yongfengtan, Zhalongtang, alt. ca. 3150-3950 m, 1. VII. 1964, Hexi no 402, HMAS 163790 (**holotypus**), isotypi in PE 0904217, HUV 21514.

Microbotryum vivipari is similar to *M. bistortarum* (DC.) Vánky (Vánky 1998) from which it mainly differs in having larger ustilospores, 11–20(–30) x 9–15 (–17.5) µm, while *M. bistortarum* has smaller ustilospores, 9–16 x 8–13 µm (Vánky 1994).

A specimen of *Anthracoidea* on *Kobresia cuneata* was collected from Sichuan Province, in southwestern China at 4700 m altitude by Prof. Yang Zhuliang in 2006. The host plant, in the section *Elyna* of the genus *Kobresia*, is an endemic Chinese species distributed in Xizang Autonomous Region, Gansu, Qinghai, Sichuan and Yunnan Provinces (Dai & Liang 2000). To date, five species of *Anthracoidea* are known on the sect. *Elyna* throughout the world, namely *Anthracoidea elynae* (Syd.) Kukkonen (Kukkonen 1963, Guo 1994), *A. xizangensis* L. Guo (Guo 2006a), *A. bistaminatae* L. Guo (Guo 2006b), *A. mulenkoi* (Piątek 2006) and *A. setschwanensis* L. Guo (Guo 2007). The recently collected *Anthracoidea* species from China is identified as *A. mulenkoi* according to its original description (Piątek 2006). *A. mulenkoi* was known only from the type locality in Pakistan, on *Kobresia capillifolia* (Decne.) C.B. Clarke. *A. mulenkoi* is new to China and the host plant, *Kobresia cuneata* is a new host for this species.

Anthracoidea mulenkoi Piątek, Nova Hedw. 83: 110, 2006. **Figs. 5-6**

Sori in ovaries, subglobose, 2–3 mm in diam., at first covered by a grayish fungal membrane, later becoming exposed. Spores mass black, semi-agglutinated. Ustilospores subglobose, broad ellipsoidal, ovoid, 16–23.5 x (12.5–)16–21 µm in plan view, 11–15 µm in side view, brown; wall evenly thickened, 1–2.5 µm, with hyaline caps on the flat sides, no internal swellings, no light reflective areas, surface minutely and sparsely verruculose.

Specimen examined—On *Kobresia cuneata* Kük. (*Cyperaceae,* det. S.R. Zhang), China: Sichuan, Xinlong, alt. 4700 m, 20. VIII. 2006, Z.L. Yang 4844, HMAS 180704.

Figs. 1-4. *Microbotryum vivipari* on *Polygonum viviparum*. Fig. 1. Sori (PE 0904217, isotype). Figs. 2-3. Ustilospores as seen by LM (HMAS 163790, holotype). Fig. 4. Ustilospores as seen by SEM. (HMAS 163790, holotype). Figs. 5-6. *Anthracoidea mulenkoi* on *Kobresia cuneata* (HMAS 180740). Fig. 5. Ustilospores as seen by LM. Fig. 6. Ustilospores as seen by SEM.

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Literature cited

Dai LK, Liang SJ. 2000. Flora Reipublicae Popularis Sinicae, Tomus 12, *Angiospermae*, *Monocotyledoneae*, *Cyperaceae* (2) *Caricoideae*. Science Press, Beijing, 1–582.

Guo L. 1994. *Anthracoidea* and allied genera in China (*Ustilaginales*). Mycosystema 7: 89–104.

Guo L. 2006a ('2005'). Two new species of *Anthracoidea* (*Ustilaginales*) from China. Mycotaxon 94: 47–50.

Guo L. 2006b. Six new species of *Anthracoidea* (*Ustilaginales*) from China. Fungal Diversity 21: 81–92.

Guo L. 2007. *Anthracoidea setschwanensis* sp. nov. (*Ustilaginales*) and a new record of *Anthracoidea* from China. Mycotaxon 99:227–230.

Kukkonen I. 1963. Taxonomic studies on the genus *Anthracoidea* (*Ustilaginales*). Ann. Bot. Soc. Zool-Bot. Fenn. "Vanamo" 34(3): 1–122.

Piątek M. 2006. *Anthracoidea mulenkoi* (*Ustilaginomycetes*), a new cypericolous smut fungus from Pakistan. Nova Hedw. 83: 109–116.

Vánky K. 1994. European Smut Fungi. Gustav Fischer Verlag Stuttgart, Jena, New York. 1–570.

Vánky K. 1998. The genus *Microbotryum* (smut fungi). Mycotaxon 67: 33–60.

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Errata

Volume 103

p.383, line 12	*for:* see **Dueñas al.**	*read:* see **Dueñas & al.**
p.384, line 9	*place* **Dokmetzian, Diana Ana** entry on line 5 (out of order)	
p.385, line 13 from bottom	*for:* see **Dueñas al.**	*read:* see **Dueñas & al.**
p.386, lines 5 & 34	*for:* see **Dueñas al.**	*read:* see **Dueñas & al.**

FROM THE *EDITOR-IN-CHIEF*

TO OUR READERS

We are pleased to report that 2008 brought with it a greatly increased number of excellent submissions to MYCOTAXON. Unfortunately, the high number of submissions brings with it a larger workload and a need to include more papers in each volume. This, combined with spsoradic internet problems, has caused our turn around times to be slightly longer than we wish. Even with 57 papers included in MYCOTAXON 104, we are already processing 45 manuscripts for MYCOTAXON 105, the July–September volume. Still, we hope to bring our average turn-around from final submission to publication back down to under 90 days after MYCOTAXON 105 goes to press.

Selecting the cover drawings from among drawings submitted in papers for each volume continues to be a pleasant challenge. We hope that over time all fungal groups by many different author/artists will be featured on the cover. The current depiction of the new species, *Minimelanolocus endospermum,* by Ma, Zhang & Zhang on the current cover joins illustrations of new species *Xerula setulosa* (Petersen & Baroni, 101), *Pseudocercospora rigida* (Silva & Pereira, 102), and *Chalciporus africanus* (Degreef & De Kesel, artist van de Kerchove, 103) on previous volumes.

Color also continues to grace our pages. MYCOTAXON 101 featured the delicate lavendar hues in cultures of *Edenia gomezpompae* (Gonzalez & al.) and Jaklitsch's excellent microphotos of *Immersisphaeria eichleriana.* The current volume presents a subtle political statement on the origins of the pathogenic *Alternaria undulata* (Roberts, p. 30), two excellent plates depicting the new *Xylaria phosphorea* (Krisai-Greilhuber & Jaklitsch, pp. 91 & 93), helpful comparisons of three *Daldinia* species (Vasiljeva & Stadler, p. 289), and a striking color plate of the new *Sinofavus allanatosporus* (Zhuang & Tolgor, p. 393).

MYCOTAXON now averages around three papers per volume that summarize annotated species lists posted on the internet. Three new summaries by Dimou & al. (pp. 39–42), Türkoğlu & al. (Turkey, pp. 365–368), and Bernicchia & al. (Italy, pp. 445–448) bring to 36 the number of weblists now posted or linked on our webpage.

MYCOTAXON 104 presents 53 new fungal names and contains 57 papers contributed by 148 authors and co-authors representing 28 countries. We are proud to be able to offer taxonomic and nomenclatural papers with a truly international mycological focus to our many readers.

—Lorelei L. Norvell,
MYCOTAXON *Editor-In-Chief*
5 June 2008

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MYCOTAXON'S complete instructions, which were last updated in November, 2007, are posted on the INSTRUCTIONS TO AUTHORS page on the MYCOTAXON website listed below. Prospective authors should download instructions PDF, expert reviewer comment and submission forms, and helpful templates by clicking the 'file download page' link on the instructions page before preparing a paper intending for the journal. Below is a summary of our simple '4-step' publication process.

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Useful references,detailed tropical distribution, and hosts or substrates are provided for each species.
CONTRIBUTING AUTHORS: Lin Gou, Shou-Yu Guo, Ying-Lan Guo, Xiao-Lan Mao, Shu-Xiao Sun, Shu-Xia Wei, Hua-An Wen, Zhi-He Yu, Xiao-Qing Zhang, Jian-Yun Zhuang & Wen-Ying Zhuang.

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